INITIAL STUDY
MANUFACTURED GAS PLANT
INVESTIGATION
SARNIA, ONTARIO

AUGUST 1989

Environment Ontario

Jim Bradley
Minister

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MANUFACTURED GAS PLANT INVESTIGATION

SARNIA

Report prepared for:
Waste Site Evaluation Unit
Waste Management Branch

Report prepared by:
Conestoga-Rovers & Associates

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EXECUTIVE SUMMARY

Conestoga-Rovers and Associates (CRA) was retained by the Ministry of the Environment (MOE) to investigate the old manufactured gas plant site in Sarnia, Ontario. The investigation was conducted in two phases. Phase 1 involved using non-intrusive geophysical methods and Phase 2 involved a drilling and sampling phase to ground truth the geophysical results.

The Phase 1 geophysical methods utilized included an electromagnetic and a magnetometer survey. The Phase 2 activities included the completion of nine boreholes on Site, with four of the boreholes being instrumented as observation wells. Air monitoring and soil sampling was conducted during drilling activities.

Subsequent to drilling activities the four observation wells were developed, monitored for water levels and sampled. Groundwater samples were collected for the analyses of general chemistry parameters, trace metals, monocylic aromatic hydrocarbons (volatiles), naphthalene and benzo(a)pyrene.

The Site is generally separated into three geologic units: fill; glaciolacustrine (interbedded peat, sand and clay) deposits; and glacial till. The fill varies in thickness from 0.4 to 2.0 metres. The total thickness of the glaciolacustrine deposits is 2.4 metres. The glacial till acts as a regionally extensive confining unit and will inhibit the vertical movement of coal tar.

The groundwater flow system at the Site is controlled primarily by the permeable units within the glaciolacustrine deposits and the presence of the underlying regional confining glacial till. Based on the results of hydraulic monitoring, groundwater flow in the glaciolacustrine unit discharges to Sarnia Bay. The horizontal groundwater velocity was calculated to be 0.47 metres/year in glaciolacustrine unit. The travel time for groundwater in this unit from the downgradient Site boundary to Sarnia Bay was calculated to be in the order of 200 to 300 years.

Coal tar NAPL (refers to that portion of coal tar which is not dissolved in groundwater and can be visually identified as a separate and distinct material) saturated sands were encountered in the glaciolacustrine deposits over the southern two-thirds of the Site. The coal tar NAPL saturated sands extend down to the top of the glacial till. The distance of contaminant movement off Site was not determined.

Based on current conditions, the coal tar NAPL on Site is covered sufficiently to prevent exposure to the waste through existing on-Site activities. Existing data also indicates that the air quality above the Site has not been affected by the presence of coal tar.

The groundwater in the glaciolacustrine deposits on Site has been impacted by coal tar APL(refers to that portion of coal tar which is dissolved in groundwater and cannot be visually identified as a separate and distinct material). The groundwater in the glaciolacustrine deposits is not used as a drinking water supply and, therefore, does not represent an existing

threat to human health in this respect. Bedding materials of adjacent service lines do not represent a preferred route of migration.

The horizontal extent of the coal tar NAPL off-Site has not been determined, however, is anticipated to be restricted to the immediate vicinity of the Site. The likelihood of coal tar NAPL from the Site reaching Sarnia Bay is extremely low.

It is recommended that the fact of coal tar contamination found on Site be registered on the land title and restrictions on future land uses be specified. Notwithstanding the foregoing, future work, including additional boreholes, observation wells and groundwater sampling is recommended to be completed on and off the Site.

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1.0 INTRODUCTION

1.1 BACKGROUND

Conestoga-Rovers & Associates (CRA) was retained by the Ministry of the Environment (MOE) to investigate the old manufactured gas plant site in Sarnia, Ontario. The Site location is presented on Figure 1.1 and the Site layout, both historic and current, is presented on Figure 1.2.

The objectives of the investigation were to:

1) determine if gasification plant wastes remain on Site;
2) if wastes are on Site, determine their context and distribution;
3) if wastes are on Site, determine if there are contaminants off Site or potential for off-Site migration; and
4) If wastes are present (on or off Site), determine if there is existing threat to human health or the environment.

To meet the above objectives, the investigation was conducted in two phases.

Phase 1 involved a geophysical survey to determine if there were any buried wastes and/or storage vessels remaining at the Site. Phase 1 activities are discussed in Section 2.0.

Phase 2 involved drilling, soil sampling, air monitoring, observation well installation, well development and groundwater sampling

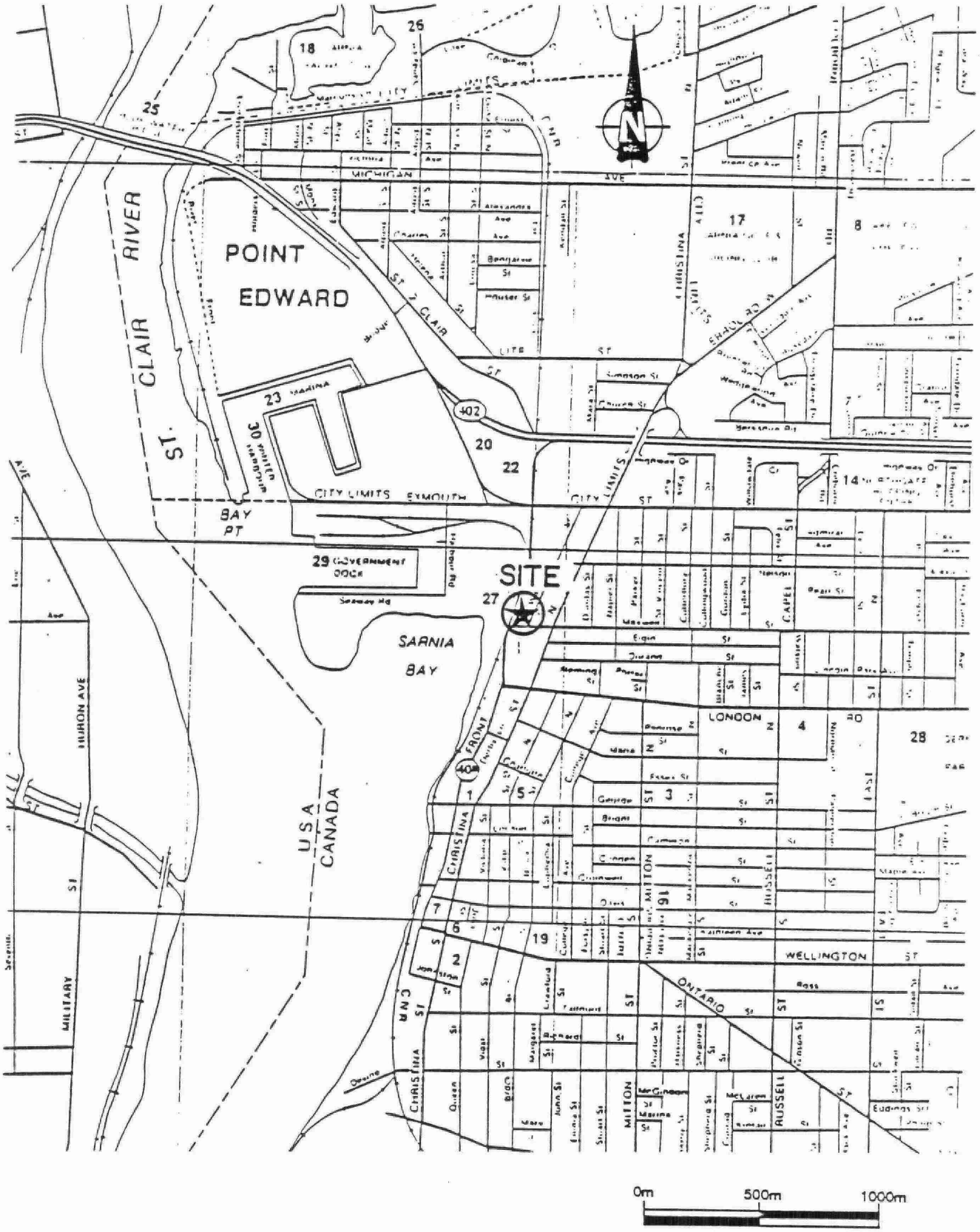

figure 1.1

LOCATION PLAN
SARNIA COAL TAR INVESTIGATION
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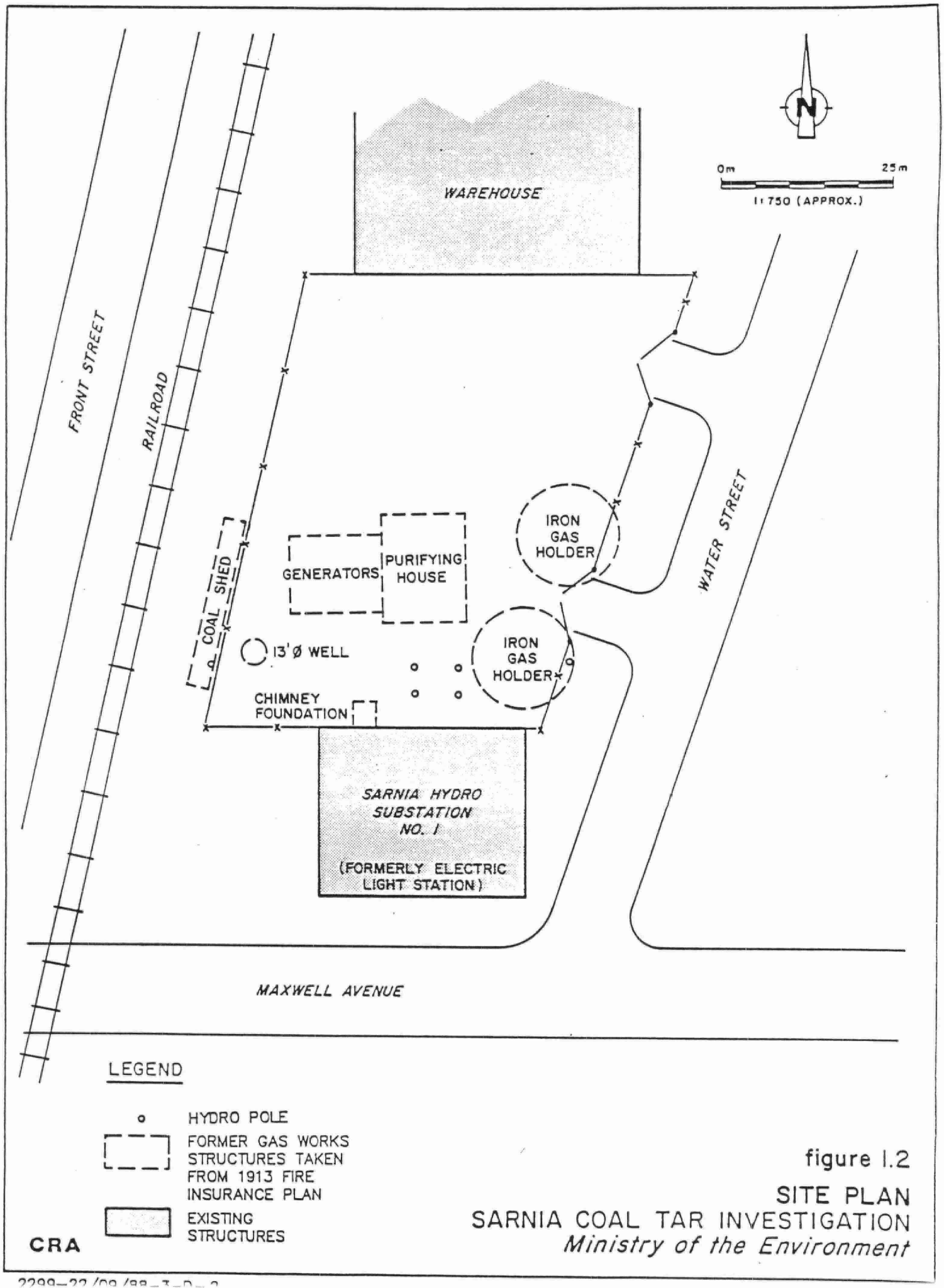

figure 1.2

SITE PLAN
SARNIA COAL TAR INVESTIGATION
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to ground truth the geophysical results and to determine the extent of gasification plant wastes on Site. Phase 2 activities are discussed in Section 3.0.

Section 4.0 presents an evaluation of the geologic/hydrogeologic conditions at the Site, and addresses the extent of visual contamination encountered at the Site.

Section 5.0 presents all the analytical data obtained during the investigation and an assessment of the data.

Section 6.0 presents recommended additional work required in order to better define the limits of visual contamination in the vicinity of the Site and data required to complete an evaluation of the threat to human health or the environment.

1.2 SITE HISTORY

The Sarnia Gas Company was incorporated in 1880. According to records, production of manufactured gas for illumination purposes first occurred at the gas works constructed on Maxwell Street, bounded by Water Street on the east and Front Street and the railway tracks to the west, in approximately 1884. Manufactured gas was produced for municipal and domestic consumption under the name Sarnia Gas Company until the early 1890s, at which time the company name changed to the Sarnia

Consumers Gas Company, and ceased in approximately 1909 under the name of the Sarnia Gas and Electric Light Company.

According to the 1913 Fire Insurance Plan for the area, the Sarnia Gas Works consisted of an iron-clad Coal Shed located on the western margin of the property adjacent to the railway line on Front Street, a single Generating House and Purifying House located in the central portion of the property and two 20,000 cubic foot telescopic Gas Holders located on the eastern margin of the property adjacent to Water Street. The 1913 Fire Insurance Plan refers to an underground oil tank on property which appears to be to the north of the Gas Works. South of the Gas Works existed the Sarnia Gas and Electric Light Company electrical substation. According to record, this station generated electricity from steam at 60 cycles until approximately 1916, at which time the Sarnia Hydro-Electric Commission took over the operation of the station and converted it to a 25 cycle facility utilizing electricity supplied via Niagara Falls and the Ontario Hydro system. This station exists to this day and is referred to as Substation No. 1.

Historic plans obtained from the Sarnia Hydro-Electric Commission, subsequent to completing the field investigations, concerning Substation No. 1, indicate the following pertaining to subsurface structures in the area of the former Gas Works property:

1. No subsurface tanks or vessels marked on these plans.

2. At one time a 20-inch Box Drain appeared to run through the Substation property and connected with an 18-inch Tile Drain along

the centreline of Maxwell Street, which subsequently discharged to the St. Clair River. This Box Drain appears to have been abandoned or otherwise removed some time ago, as the old plans show it as being eliminated. It is not known whether this Box Drain serviced the former Gas Works.

3. A plan of 1935 depicting the surface water drain on Maxwell Street from Front Street to the St. Clair River shows only a tie-in from Substation No. 1 to the 18-inch Tile Drain along the centreline of Maxwell Street.

4. The base of a former chimney stack located on the north side of Substation No. 1, against the building, is shown as being 6 feet in diameter. It is not known whether the foundation of this chimney remains as such.

5. A large 13-foot diameter well is shown as being located in the southwest corner of the former Gas Works property adjacent to the railway line. The former use of this well is not known. Evidence of the well location was noted during a Site inspection in July 1988.

Additional documentation concerning the operation and management of the Sarnia Gas Works is virtually non-existent. Any documentation which may have existed concerning this facility, particularly as it relates to on-site storage, distribution and byproduct disposal facilities, and off-site byproduct disposal facilities, has apparently been long-since misplaced or destroyed. An advertisement placed in the Sarnia Observer for

the week of March 22, 1988, requesting persons with any knowledge of the former facility to contact CRA, produced a single response which dealt with broad historical matters concerning mainly natural gas in Sarnia as a whole. A former General Manager of Sarnia Hydro produced an unsolicited photograph of the demolished gas works, taken in approximately 1916, which lends support to the claim that the Gas Works was at least partially demolished prior to this date. No known on-site, or off-site, byproduct disposal areas have been identified.

2.0 PHASE 1 - GEOPHYSICAL SURVEY

The objective of the geophysical survey was to determine if there were any buried wastes and/or storage vessels remaining at the Sarnia Site. A review of the local geology as well as past information on the Site provided by Intera (1987a) assisted in the selection of the geophysical methods utilized at the Site. The methodology and results of the surveys are outlined below.

2.1 METHODOLOGY

A 20-foot (6 metre) interval sample grid spacing was established prior to undertaking the geophysical surveys. Eastings and northings were assigned to each location. The perimeter of the grid was delineated by flagging tape for future reference and the established grid was infilled by pacing. The grid for the geophysical surveys is presented on Figure 2.1.

The shallow sensing Geonics EM31 electromagnetic instrument was chosen for the terrain conductivity survey to map the bulk conductivity of the earth materials to a depth of approximately 4.5 metres. The electromagnetic (EM) instrumentation is designed to detect terrain conductivity by utilizing a current flow induced in the subsurface materials by a surface transmitter. An alternating electric current produced in the transmitter coil generates an alternating magnetic field. The magnetic field penetrates the ground surface and induces current flow through the earth materials which in turn induces a secondary magnetic field. The secondary

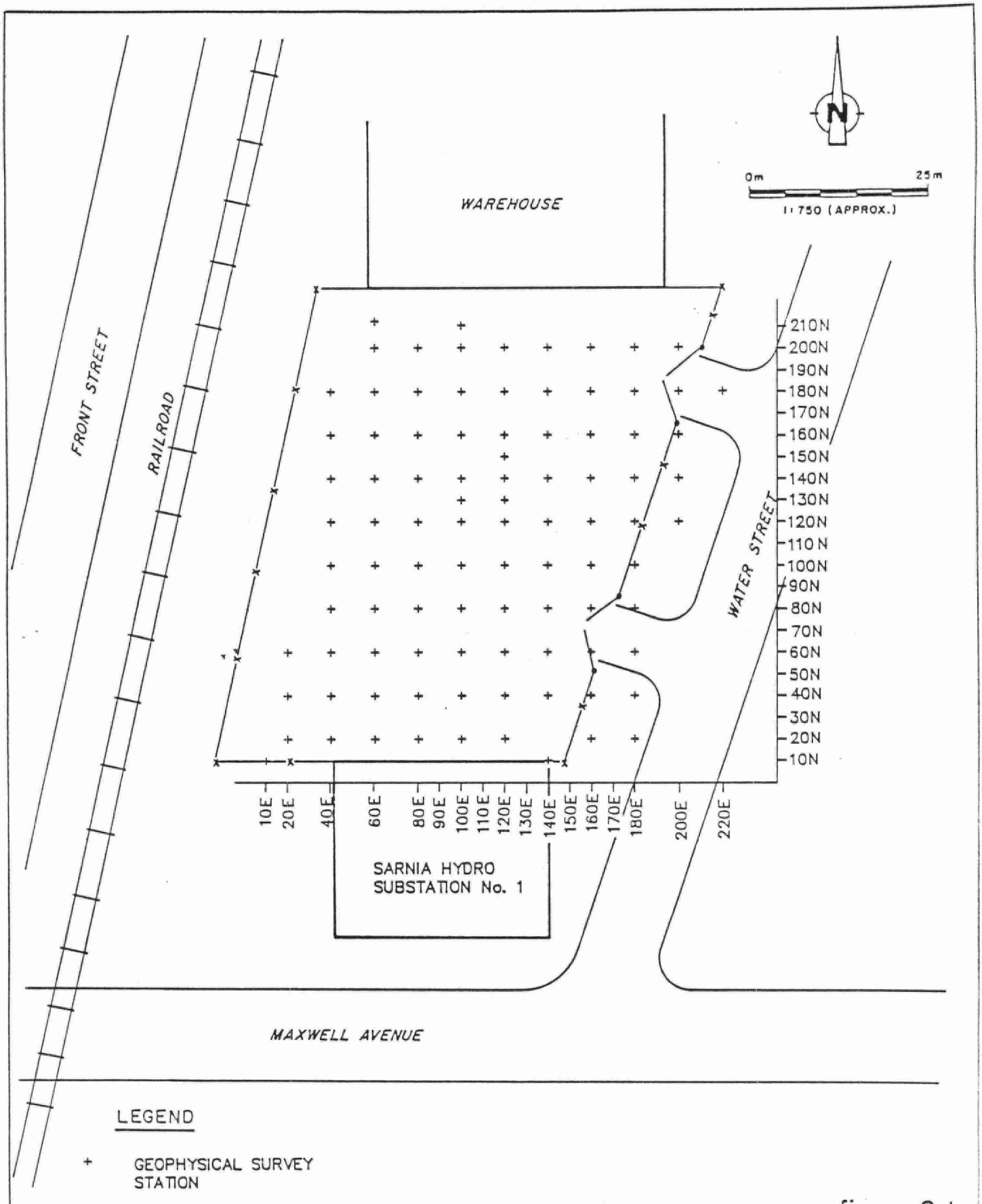

figure 2.1

GEOPHYSICAL SURVEY SAMPLING GRID
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magnetic field sensed at the receiver coil depends on the strength of the primary field, current frequency, distance between transmitter and receiver coils (factor considered constant for the EM31), and the presence of a conductive body. The EM31 is portable permitting data to be collected rapidly and continuously as the operator and the instrument move across the land surface.

The Geonics EM31 instrument has transmitter and receiver coils separated by a rigid boom 3.6 metres in length. The device reads in milliSiemen per metre (mS/m). Generally the conductivity obtained with the EM31 will vary smoothly from one region to the other. In some cases, however, as for example where a well defined vertical contact separates a poor conductor from a very good conductor, edge effect may be seen in which the readings vary rapidly with position and are no longer a good indicator of terrain conductivity. This effect is often evident in areas where several metallic (ferrous) pipes and/or vessels are intersected along the line of traverse. The EM also suffers loss of detection ability when the soil's electrical conductivity rises above 40 mS/m. This response is characteristic of soils with high clay and/or water content.

The bulk conductivity of the earth materials is influenced by such factors as moisture content, geological composition, stratigraphy, and the presence of contaminants. The EM31 has been used to locate buried drums, pipes, cables, cavities and tunnels, as well as in the mapping peat thickness and the extent of leachate plumes.

Magnetometers can also be utilized to detect perturbations in the geomagnetic field created by buried ferromagnetic objects such as steel tanks and pipes. The magnetometer can detect buried objects at depths much greater than that of a metal detector. The most common instruments currently in use are the gradiometric and the proton precession magnetometers. The proton precession magnetometer typically measures the magnetic susceptibility of the total field. That is to say that it is capable of sensing both the vertical and horizontal field components. The gradiometric magnetometer has the advantage in being able to sense the vertical field component while remaining relatively insensitive to the horizontal field component. This feature allows the instrument to sense subsurface targets in the presence of anthropogenic interferences such as steel fences.

The magnetometer is portable permitting data to be collected rapidly and continuously as the operator and the instrument move across the land surface. In soils with minimum interference, individual steel containers, for example, can easily be detected to a depth of three metres. No problems are evident with the magnetometer survey being conducted in a cohesive soil. Problem could arise with the EM in cohesive soils due to the usual high water content and soil inhomogeneity. The McFar Fluxgate Magnetometer (MAG) is a gradiometric magnetometer used in the search work at the Sarnia Site.

The use of two different methods concurrently at the Site makes data interpretation easier, particularly under difficult Site conditions. Comparison of data from the two techniques yields more information and confidence in the evaluation of Site conditions. The results of the

geophysical surveys were used to most appropriately site boreholes during the Phase 2 investigations at Sarnia.

A computer aided "nearest neighbor" mapping package was used to store, manipulate and present the EM and MAG data. The nearest neighbor package is the simplest search method that finds the nearest neighboring data point, in an Euclidean (geometric) distance sense, regardless of their angular distribution around the point being estimated. This method is fast and satisfactory if control points (instrument readings) are distributed in a comparatively uniform pattern and is based on the intuitively appealing idea that a nearby observation point is a better estimate of the value of a point on a surface than a more distant one, and that a small number of nearest control points provide essentially all the information that is relevant to the estimate.

2.2 GEOPHYSICAL SURVEY RESULTS

The EM31 was operated continuously using the inphase component with measurements taken at 6 metre (20 foot) intervals and any anomalous readings observed between stations recorded at their actual substation. Readings were taken with the instrument both parallel and perpendicular to the line of traverse. The results of the EM31 survey for Sarnia are presented in Appendix A. The normalized EM31 survey results are presented in Figure 2.2.

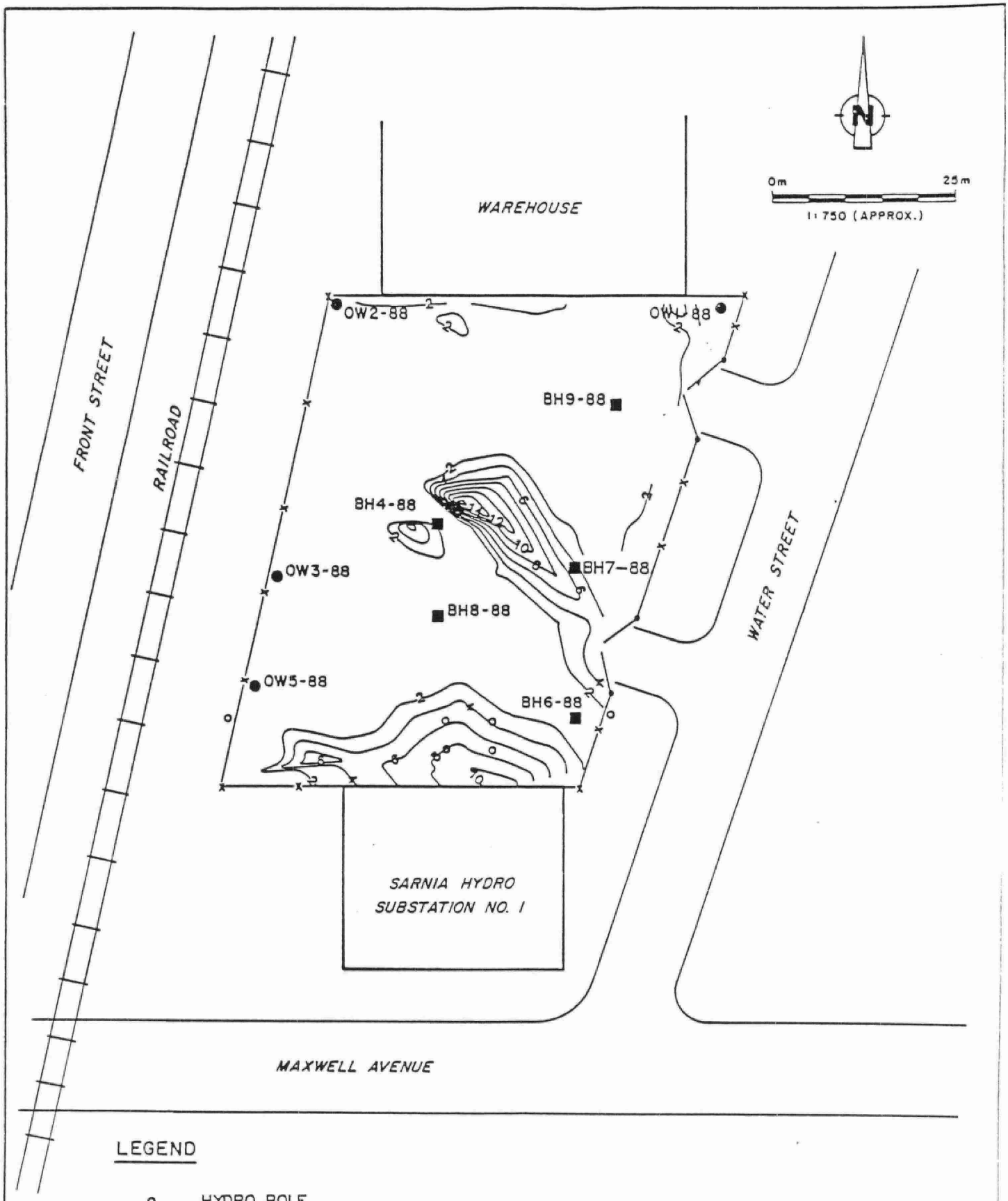

figure 2.2

GROUND CONDUCTIVITY SURVEY (EM31)
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The average value for the parallel and perpendicular conductivity readings were used for the data reduction. Background readings were taken outside the Site boundary, parallel to Front Street between the fence and the railway tracks. In displaying the EM31 data, the ratio of the surface conductivity to the background conductivity represented in equal logarithmic units, was utilized. Decibel (db) units were multiplied by 20 to give convenient whole numbers and were contoured. The "0 db" contour outlines background data and a contour interval of 2 db portrays successive factors of about 0.8 above background conductivity.

The MAG survey was conducted on the established grid upon completion of the EM31 survey. The instrument was operated continuously and any anomalous readings observed between stations were recorded at their actual substation. The results of the MAG survey are also presented in Appendix A and on Figure 2.3. An average background reading of 4900 gammas was determined for the MAG survey.

The Site is relatively small and a number of anthropogenic sources of interference on the two surveys conducted were noted. The sources of interference included the fence surrounding the Site, the electrical transformers and overhead power lines, and the Sarnia Hydro substation. The overhead wires located along the southern boundary of the Site tend to increase the conductivity and magnetometer measurements and are characterized as linear or elongated features on the respective contour maps.

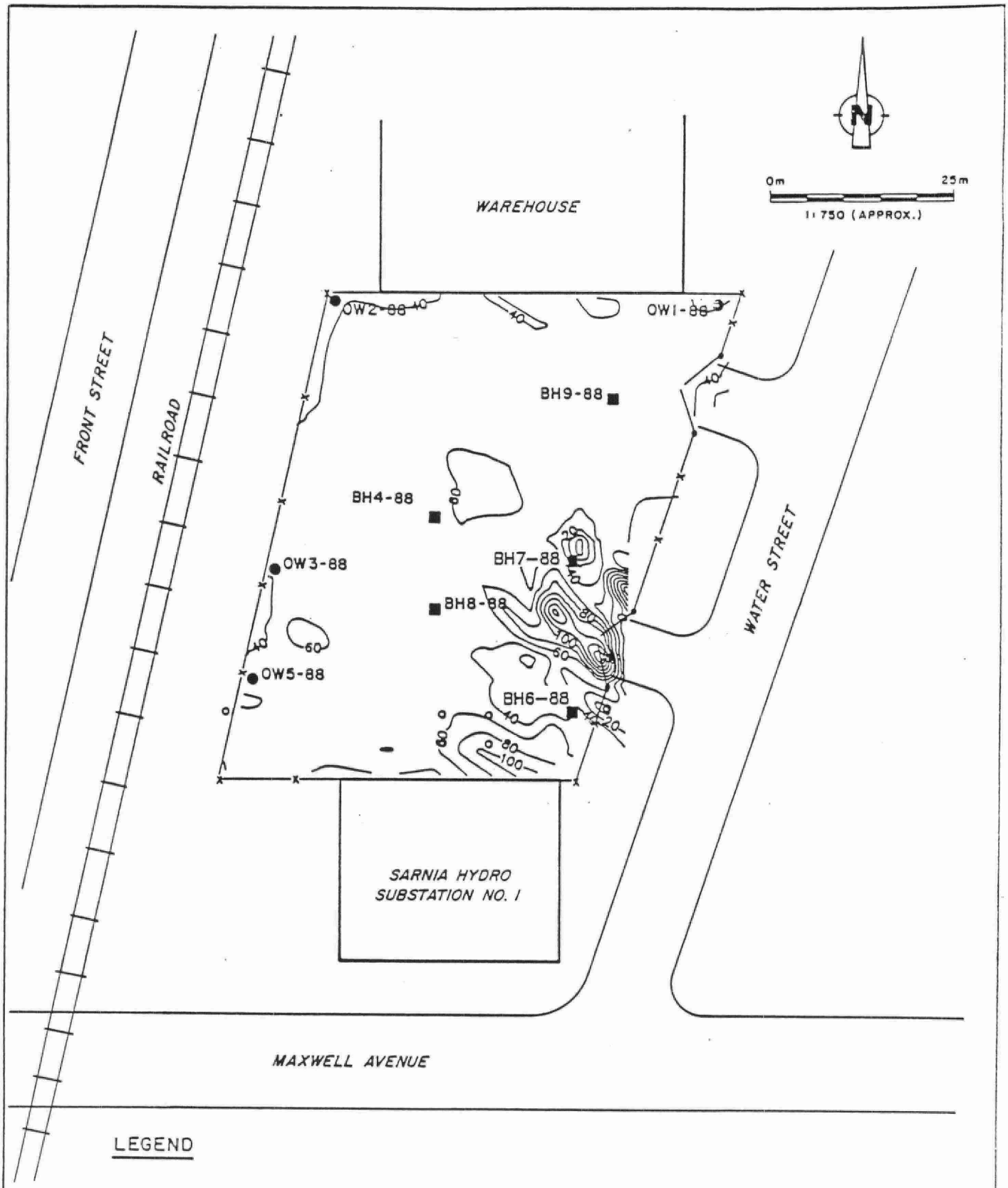

figure 2.3

MAGNETOMETER SURVEY
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A review of Figures 2.2 and 2.3 indicated that there were several potential drill site locations within the fenced boundaries of the Site. A review of the data indicated that boreholes located along the northern boundary of the Site would be representative of background conditions at the Site. The linear or elongated results of the EM31 and MAG surveys in this area are attributed to the chain link fence. The central portion of the Site was characterized by both magnetic and ground conductivity anomalies and represented the area of the Site most likely to contain contamination and/or buried structures. Boreholes were subsequently sited such that a definition of the observed trends could be established.

3.0 PHASE 2 - SUBSURFACE FIELD ACTIVITIES

Field activities undertaken during Phase 2 included: drilling; soil sampling; observation well installation; well development; and, groundwater sampling.

The drilling program at the Site was designed to provide geologic and hydrogeologic data to ground truth the geophysical results and to determine the presence and extent of coal tar contamination on Site. Local stratigraphy was determined from the borehole logs, and piezometers were installed to determine the groundwater levels and provide water samples for chemical analysis. Details of the drilling program conducted at the Site are summarized below.

3.1 DRILLING AND MONITORING WELL INSTALLATION

The drilling program for Phase 2 activities was conducted between March 11, 1988 and March 14, 1988 by the drilling division of Environmental Systems Canada (ESC). All boreholes were advanced using a truck-mounted Mobile B-61 drilling machine equipped with 6-5/8 inch (168 mm) internal diameter (I.D). hollow stem augers. Soil samples were collected continuously to complete depth. Prior to mobilizing to the Site, the drill rig and all associated tooling was decontaminated.

The decontamination procedures consisted of a thorough steam cleaning of the rig and all associated equipment prior to mobilization

onto the Site to remove oil, grease, mud, etc. Subsequently, before initiating drilling at each borehole or observation well location, the augers, cutting bits, samplers, drill steel and associated equipment were cleaned to prevent cross-contamination from the previous drilling location. The cleaning was accomplished by flushing and wiping the components to remove all the visible sediments followed by a thorough high pressure wash and rinsing. The split spoon and continuous sampler were further cleaned by a methanol/deionized water rinse. All rinse liquids were containerized for future disposal (see Section 3.6.2).

At each drilling location, a temporary work zone was established with the dirty work zone being demarcated as an exclusion zone. Within the exclusion zone, all work related to soil sampling was carried out by personnel equipped with appropriate personal protective equipment (PPE) at a minimum level equivalent to USEPA level "C"with the exception that half-face respirators were worn only when the working environment warranted them (see Section 3.3). Establishment of the exclusion zone included covering the ground in the immediate area with 3 mil plastic sheeting and plywood, on which all work was conducted.

Real-time air monitoring was conducted using portable photoionization detector (HNu), and by an olfactory survey. The meter used is sensitive to the volatile components of coal/oil tar including the aromatics and naphthalene in the 1 ppm range, but is not specific as to which are present. CRA periodically monitored downwind of the Site during the drilling operations to determine if organic vapors were migrating off-Site. Air monitoring conducted at the Site is discussed in Section 3.3.

The drilling program commenced in an area assumed to be representative of background conditions as defined by the geophysical surveys and progressed in sequence from assumed clean to dirtier areas. Upon completion of each hole, all augers and sampling equipment were thoroughly decontaminated. Each sampler was cleaned between samples as well.

As drilling progressed, the soil samples were visually examined by a CRA geological technologist and classified according to the Unified Soil Classification (Wagner, 1957). Soil samples collected were placed in glass jars for future reference and/or chemical analysis. Obviously contaminated drilling spoils were sequestered and drummed for later disposal (see Section 3.6.1.). The remaining drilling spoils were used as backfill. Boreholes which were not instrumented with observation wells were backfilled to ground surface with cement/bentonite grout.

Nine boreholes in total were completed during the subsurface investigation. Drilling was not conducted beyond the fenced boundary of the Site. All drilling locations are shown on Figure 3.1. The boreholes were predominantly advanced to a unit of relatively low permeability encountered below the peat, unless contamination was encountered. One borehole (OW1-88) was extended to a depth of approximately 9 metres to determine the geology at depth.

Four boreholes were instrumented as observation wells to determine the position of the water table, the direction of groundwater flow,

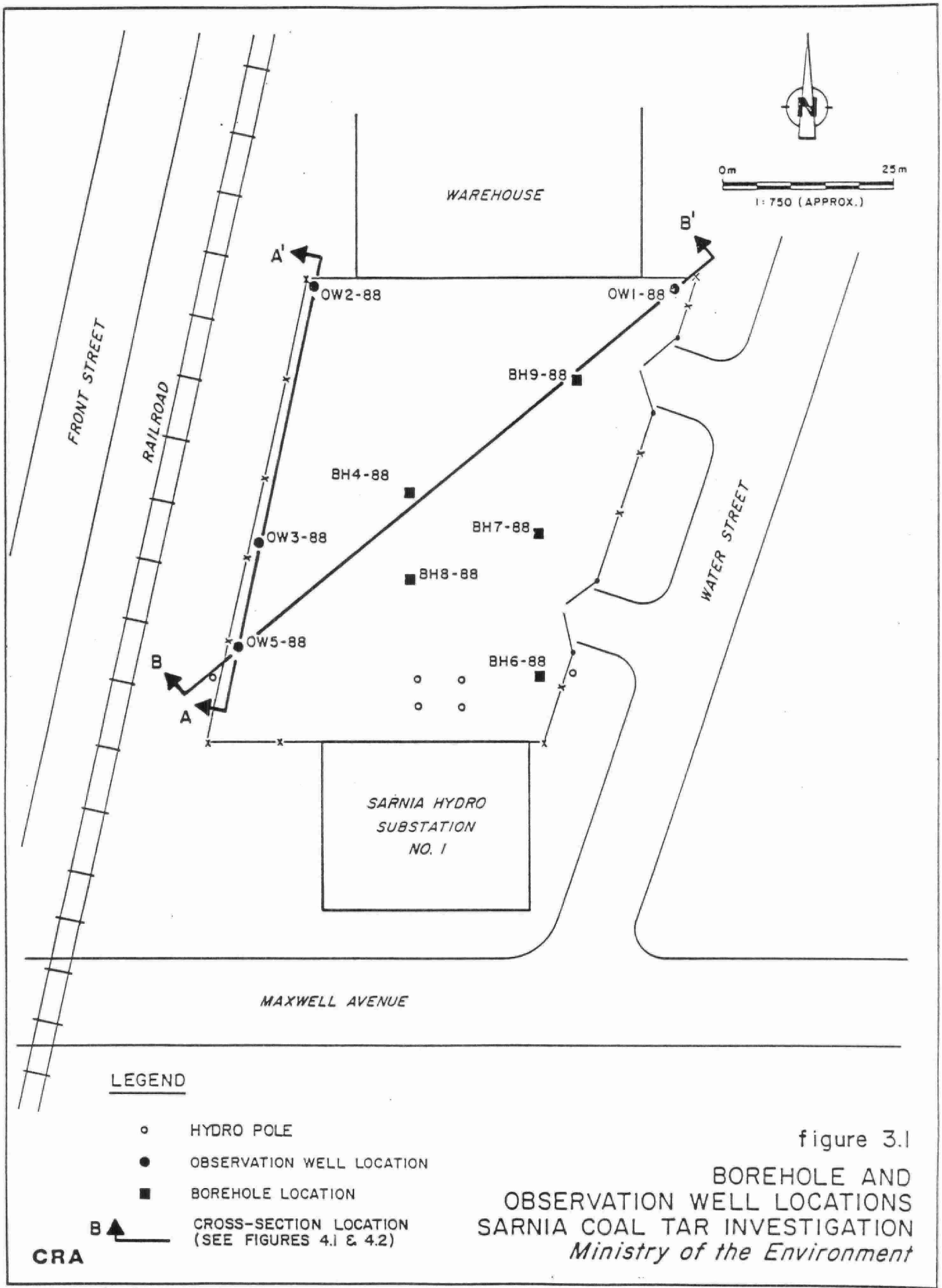

figure 3.1

BOREHOLE AND
OBSERVATION WELL LOCATIONS
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and provide water chemistry data. Two boreholes, BH4-88 and BH7-88 were installed in areas characterized by both EM31 and MAG anomalies located near the centre of the Site. Observation well construction details are summarized on Table 3.1. Copies of stratigraphic and instrumentation logs for the observation wells are presented in Appendix B. Stratigraphic logs were not generated for the boreholes since they were all shallow borings, however, a borehole details summary has been compiled and is presented in Section 4.3 on Table 4.1.

The observation wells were placed through the stem of the augers. Well construction materials primarily consisted of 50 mm diameter threaded flush joint schedule 80 PVC with 50 mm diameter #10 slot screens. Although PVC has limited resistance to tar materials, it is suitable in short term monitoring programs such as the one undertaken in Sarnia. The borehole annulus around each screen was filled with a graded sand pack to approximately 0.6 metres above the top of the well screen. A bentonite pellet seal, approximately 0.6 metres thick, was placed above the sand pack. The remainder of each well was then backfilled to ground surface with cement/bentonite grout. The observation wells were not supplied with protective casings as all wells were completed within the fenced boundary of the Site.

Following completion of the observation wells and boreholes, all wells and boreholes were surveyed by CRA personnel for horizontal and vertical control. An assumed datum point at the top of the fire hydrant in front of 404 North Front Street was used as a vertical control. The Site was resurveyed in July, 1988, using a reference datum point located

TABLE 3.1

WELL CONSTRUCTION DETAILS

Well #	Date Completed	Ground Elevation (m AMSL)	Top of Pipe Elevation (m)	Total Depth (m BGS)	Screened Interval		Screened Unit
					Depth (m BGS)	Elevation (m AMSL)	
OW1-88	11 Mar 88	178.53	179.238	9.1	1.07-1.83	177.46-176.70	silt
OW2-88	11 Mar 88	178.50	179.527	4.6	1.07-1.83	177.43-176.67	sand/silt
OW3-88	14 Mar 88	178.52	179.436	3.1	1.52-3.05	177.00-175.47	sand/silt
OW5-88	14 Mar 88	178.60	178.213	3.1	1.37-2.20	177.23-176.40	sand

the south area of the first fire hydrant located on Front Street, north of Maxwell Avenue. The reference elevation was provided by the City of Sarnia.

3.2 SOIL SAMPLING

As discussed in Section 3.1, soil samples were collected continuously to completed depth of all boreholes. Soil samples collected for stratigraphic definition were placed in precleaned glass jars and transported to CRA's warehouse in Waterloo, Ontario for future reference. Selected samples, as discussed in Section 5.2, were chosen for waste characterization, to confirm the identity of the waste, and were submitted to OceanChem Group of Dartmouth, Nova Scotia (OceanChem).

3.3 AIR MONITORING

Site boundary, exclusion zone breathing space, and auger stem air monitoring was conducted during the drilling program, using an HNu meter. The unit was calibrated daily using 64.2 ppm butane calibration gas.

During drilling, air monitoring was conducted periodically or when a PAH odour was noticed. HNu readings in the auger stems and the breathing space within the exclusion zone were monitored and

recorded. Criteria for determining the level of health and safety adhered to during drilling is summarized on Table 3.2.

Site boundaries were also monitored to detect any migration of aromatics from the Site as a result of drilling operation. No noticeable discharges were evident as all readings along the fence lines, were considered to be background (ranging from 0.5-1.5 ppm).

3.4 WELL DEVELOPMENT

All observation wells installed during this program were developed to ensure that the hydraulic and chemical data obtained from each well was representative of formation conditions. Development was performed using a top-loading copper bailer attached to a stainless steel leader and a length of nylon rope. New nylon rope was used at each well. Prior to use in each well, the bailer was cleaned using a methanol/deionized water rinse.

A minimum of three well volumes of water was removed from each of the wells or the wells developed until three consecutive and consistent readings of conductivity and pH were obtained. A summary of well development information is presented on Table 3.3.

All development water and rinse water was collected and containerized in drums on Site for later disposal (see Section 3.6.2).

TABLE 3.2

HEALTH AND SAFETY CRITERIA

WORKING ENVIRONMENT	HNu (1) READING	HEALTH AND SAFETY LEVEL	PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIRED (2)
No Hazards	1.0-5.0	Level D - intermittent air monitoring	Coveralls, cotton gloves, hard hat, steel toe work boots
Suspected Unknown Hazards	5.0-15.0	Level C - intermittent air monitoring	Tyvek coveralls, latex surgical gloves, nytrel butel gloves, half face respirator complete with acid gases & organic vapour cartridges
Known Hazards	>15	Level B - continuous personal air monitoring	Saranex coveralls, inner latex gloves, outer nytrel butyl gloves taped to coveralls, full face respirator with supplied breathing air (SCBA), hard hat, steel toe work boots

Notes:

(1) HNu reading measured in breathing space
(2) Health and Safety protocols developed by and utilized by CRA

TABLE 3.3

WELL DEVELOPMENT SUMMARY

Well No.	Date Developed	Three Well Volumes (liters)	Volume Purged (liters)	pH	Conductivity (umhos/cm)
OW1-88	3/23/88	9	17	6.74 6.83 7.18 6.92	1170 1160 1150 1150
OW2-88	3/23/88	3.5	28	7.05 7.03 7.01 7.02 7.06	1140 1020 1010 1010 1000
OW3-88	3/23/88	7.5	20	7.04 6.95 6.99 7.01 6.90	910 950 980 1030 1050
OW5-88	3/23/88	7	21	6.97 6.96 6.99 6.97	1600 1560 1540 1550

3.5 GROUNDWATER SAMPLING

Subsequent to the completion of well development activities, a complete set of groundwater samples were collected from the observation wells on March 23, 1988. Groundwater samples were collected with the bailer utilized for well development. Subsequent to well development and prior to sample collection, the bailer was cleaned using a methanol/deionized water rinse. A blind duplicate sample was also collected to provide quality control on the sampling program.

Groundwater samples were collected for the analyses of those parameters summarized on Table 3.4. Samples were generally poured directly from the bailer into the appropriate sample container. Samples for metals analysis were field filtered using a 0.45 micron filter (millipore aseptic or equivalent) prior to transfer to the sample container. Sample containers for metals and thiocyanate analyses were preserved with HNO_3 (to pH <2) and NaOH (to pH >12), respectively. The sample containers were then packed on ice for storage and shipped to the appropriate laboratory (see Table 3.4) for analyses. Throughout sample collection and shipping, chain-of-custody procedures were employed.

During the sample collection from OW3-88, an odour similar to that associated with pesticides was noted by CRA sampling personnel. An additional groundwater sample was, therefore, collected to accommodate pesticide analysis, if required. It was subsequently determined,

TABLE 3.4

WATER ANALYSIS PARAMETER LIST

PH (field)

Calcium (Beak)
Magnesium (Beak)
Sodium (Beak)
Potassium (Beak)

Trace metals (Beak) by DCP scan: Al, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sr, V, Zn

Alkalinity (CRA)
Bicarbonate (CRA)
Sulfate (CRA)
Sulfite (CRA)
Chloride (CRA)
Thiocyanate (CRA)
Ammonium (CRA)
TKN (CRA)
COD (CRA)
TOC (Beak)
Phenols (CRA)

Volatiles (Novalab): monocylic aromatic hydrocarbons which include benzene, toluene, xylenes, ethylbenzene

PAHs (Novalab): naphthalene, benzo(a)pyrene

through discussions with CRA and MOE, that this sample be submitted to Novalab for pesticide/PCB analysis.

3.6 WASTE MATERIAL HANDLING

3.6.1 Soil Cuttings

During drilling, visually contaminated drilling spoils, personnel protection equipment and any wastes generated as a result of drilling activities, were sequestered and drummed. The drummed waste was stored on the Sarnia Hydro Site, within the fenced enclosure and was further delineated with caution tape. All drum lids were securely fastened.

On July 13, 1988, under the supervision of CRA personnel, a total of seven 45-gallon (205-litre) drums containing wastes, were loaded onto a flatbed trailer for off-Site disposal at Tricil Ltd. in Carunna, Ontario. A copy of the MOE manifest for the wastes is presented in Appendix C.

3.6.2 Wash Water and Development Water

All wash waters and development waters generated during the Site investigations, were collected and drummed. The drummed waters, approximately 615 litres (135 gallons) were stored on Site, with the soil cuttings, as discussed in Section 3.6.1.

According to the MOE guidelines, "Management of Waste Contaminated Soils at Abandoned Coal Gasification Sites", water collected from coal tar waste sites may be discharged to municipal sanitary sewers provided discharge requirements are met. Benzo(a)pyrene (BAP) is the recommended indicator parameter for calculating discharge requirements of the waters. The maximum allowable concentration of BAP discharged to the sanitary sewer from coal gasification sites is required to be calculated to ensure that the additional incremental concentration of BAP in sewage treatment plant effluent is not increased by more than 10 ppt (0.01 ug/L).

Based on the MOE guideline, the maximum discharge rate of the waters to the sanitary sewer was calculated to be 305 litres per minute (see Appendix D). The discharge rate was calculated based on an average sewage treatment plant flow rate of 11,000,000 gpd (34,757 litre/min), solubility limit of BAP in water of 3.8 ug/L and a treatment plant removal efficiency for BAP of 70 percent.

Based on the total volume of waters at the Site (615 litres), and the discharge rate of 305 litre/min., the discharge of water was calculated to require a minimum discharge period of two minutes. Upon review of the discharge flow rates discussed above, the City of Sarnia's City Engineer, approved discharge of the waters to the sewers.

On July 13, 1988, the total volume of waters on Site (615 litres) were discharged to the second sanitary manhole on Water Street north of Maxwell Avenue. The waters were discharged over a total time period of approximately 20 minutes, thereby satisfying the MOE guidelines.

4.0 GEOLOGIC/HYDROGEOLOGIC EVALUATION

4.1 REGIONAL SETTING

4.1.1 Regional Geology

The former coal gasification plant at Sarnia is located in the Huron Fringe Physiographic region (Chapman and Putman, 1966). The region is characterized by the wave cut terraces of glacial Lake Algonquin and the subsequent Lake Nipissing. The surficial materials are primarily glaciolacustrine deposits laid down as shoreline and near shoreline deposits. These materials consist of a mixture of sand, silt, and minor gravel.

The glaciolacustrine deposits are underlain by the St. Joseph Till, a clayey silt till. In many areas the till unit is underlain by a coarse sand and gravel unit. This unit is thin, generally less than three metres.

The total thickness of the glacial overburden at Sarnia varies from 33 to 37 metres. The uppermost bedrock unit in the area is the Devonian Kettle Point Formation. This formation is a dark brown to black, bituminous shale, with occasional interbeds of green shale.

4.1.2 Regional Hydrogeology and Groundwater Use

The major regional aquifer in the Sarnia area is termed the Freshwater Aquifer. It is made of a poorly sorted sand and gravel unit located at the bedrock contact. The aquifer is confined by the overlying St. Joseph Till. Groundwater flow within the Freshwater Aquifer is westerly towards Sarnia Bay located along the St. Clair River. The estimated depth to the Freshwater Aquifer at the former gasification plant is 45 metres below ground surface.

The groundwater is not utilized as a source of supply in the immediate vicinity of the Site. The closest known supply wells are located 2 km north of the Site at the Sarnia Golf Club. The water well records indicate that three wells have been completed at the golf course, one in the bedrock and the two in the glacial overburden to a depth of ten metres. There is no indication as to which well is currently in used at the golf course although the availability of groundwater in the glaciolacustrine units is unknown. The water from the well is used for watering the golf course.

4.2 SITE DESCRIPTION

4.2.1 Site Geology

The following description of the Site geology is interpreted from boreholes drilled during this study. The Site geology can

generally be separated into three major units based upon the regional geology presented earlier. These units are:

1) Fill;
2) Glaciolacustrine deposits consisting of interbedded peat, sand and clay; and
3) Glacial till.

The distribution of the stratigraphic units at the Site are shown on two cross-sections presented on Figures 4.1 and 4.2. The locations of the cross-sections are shown previously on Figure 3.1. The various stratigraphic units are described below.

Fill

The uppermost unit across the entire Site is fill. The fill consists for the most part of fine sand which originated from a nearby foundry. The fill varies in thickness from 0.4 to 2.0 metres. The thickest fill deposits encountered were along the southeast margins of the Site near BH6-88 and BH7-88.

Glaciolacustrine Deposits

The glaciolacustrine deposits at the Site consists of a series of beds of peat, sand, silt and clay. The total thickness of the glaciolacustrine units was determined to be 2.4 metres. Previous studies conducted by CRA, approximately 215 metres south of the Site, indicated the thickness of the glaciolacustrine deposits were on the order of 7.4 metres. Intera (1987b)

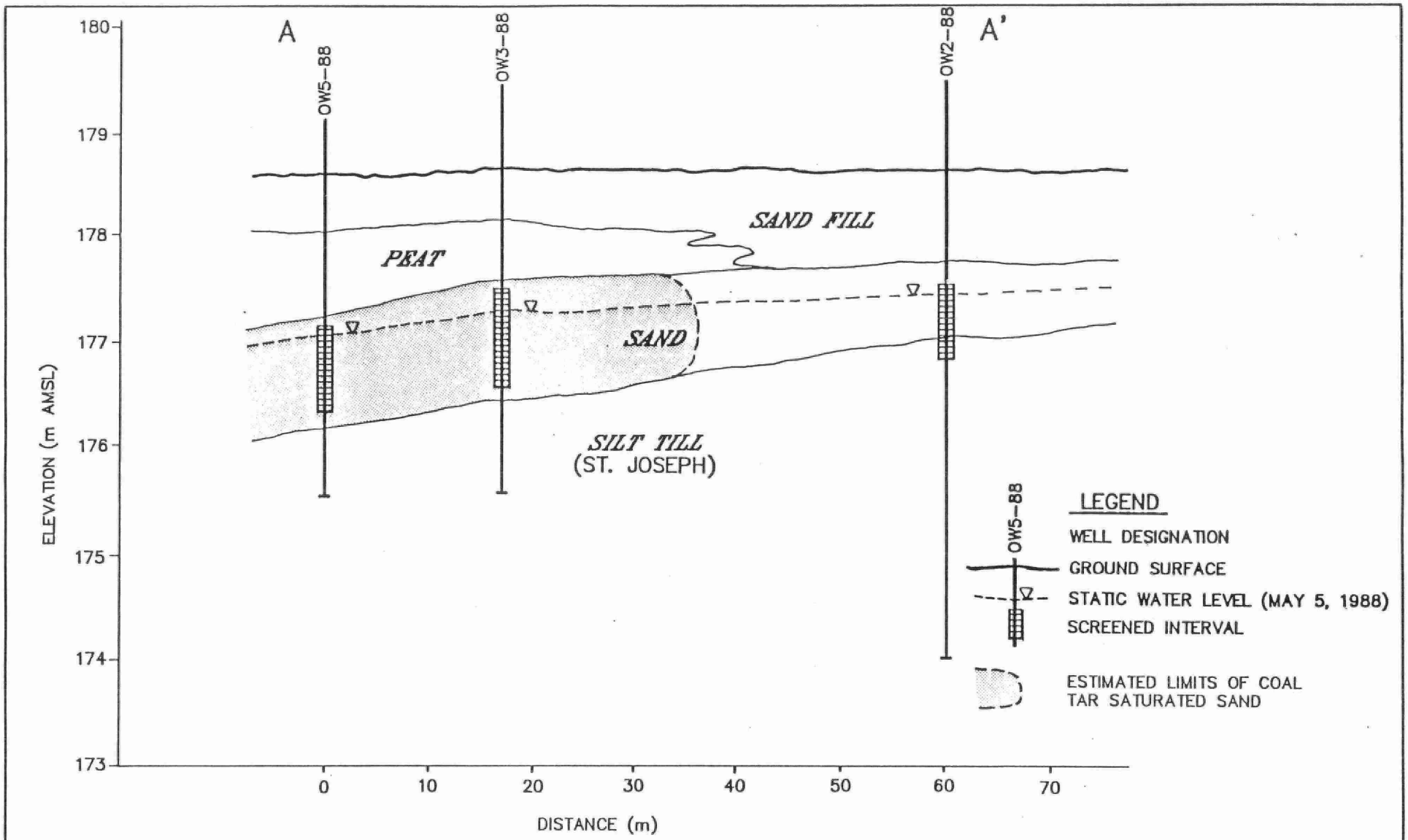

figure 4.1

SECTION A–A'
SARNIA COAL TAR INVESTIGATION
Ministry of the Environment

CRA

2299-22/09/88-3-D-2

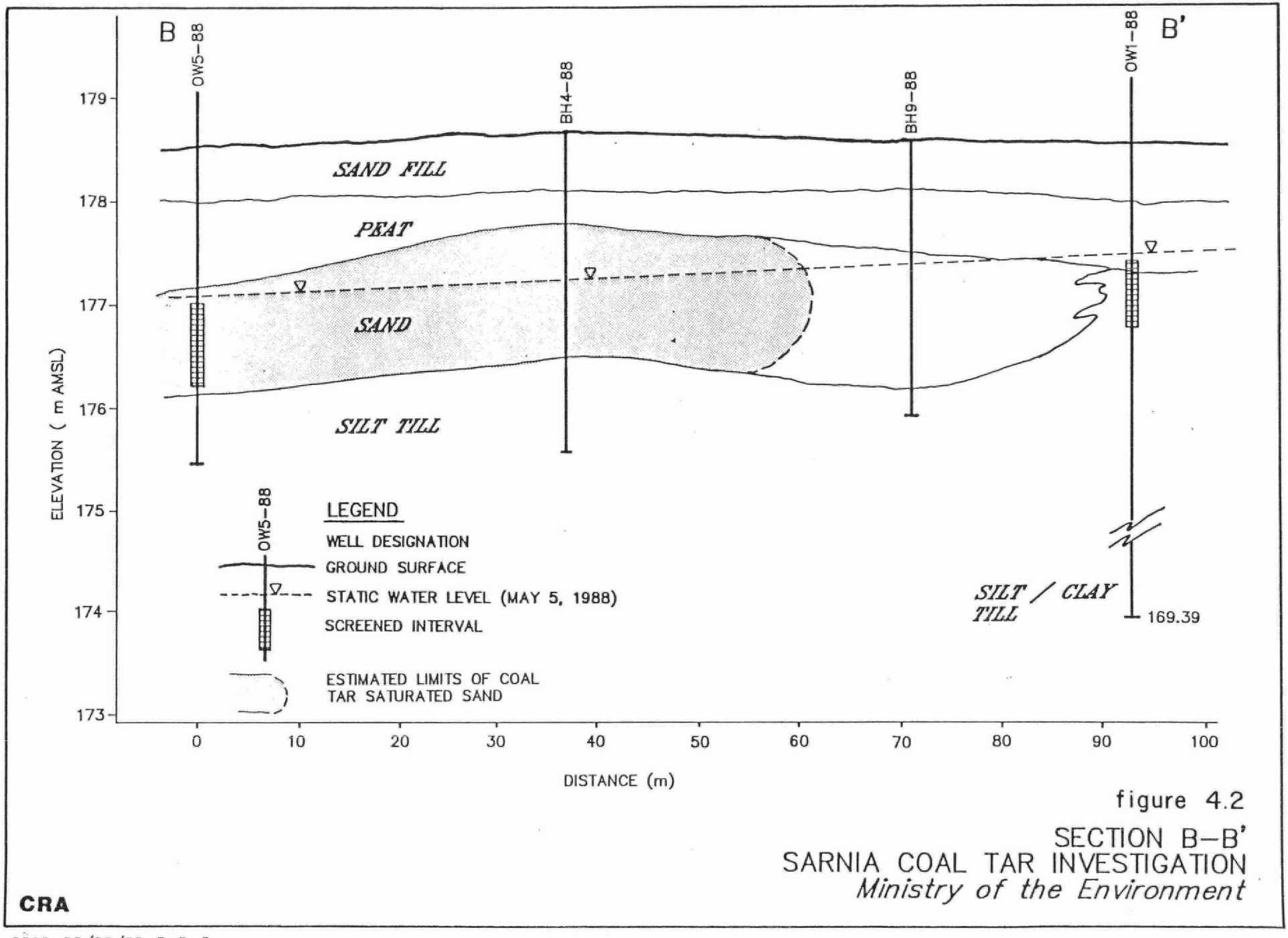

figure 4.2

SECTION B–B'
SARNIA COAL TAR INVESTIGATION
Ministry of the Environment

CRA

2299-22/09/88-3-D-2

reports the thickness of the glaciolacustrine deposits on the order of 9.1 m thick at MSMW2-87 located adjacent to Sarnia Bay. An extended cross-section from the Site to the location of MSMW2-87 is presented on Figure 4.3. A copy of the stratigraphic and instrumentation log for MSMW2-87 is presented in Appendix E.

The upper bed of the glaciolacustrine deposits consist of peat or sand. The peat bed is found at the centre of the Site, generally trending northeast to southwest. The areal extent and thickness of the peat deposit is presented in Figure 4.4. The peat is amorphous and compact, and ranges in thickness from 0.4 to 0.8 metres. The peat bed is underlain by a bed of sand and silt. This bed varies in thickness from 0.2 to 1.4 metres.

Where the peat was absent, a sand unit was encountered beneath the fill. At the northwest corner of the Site, the sand unit was well graded and wet. At the southeast corner, however, the sand unit was siltier and poorly graded. The thickness of the fill overlying the sand at BH6-88 and BH7-88 (see Table 3.3) may be indicative of excavation of the peat during the construction or decommissioning of the former gasification plant.

Glacial Till

A silt till was encountered beneath the sand at six boreholes. The till was encountered at a depth of 1.5 metres below ground surface at OW1-88 and OW2-88 located along the northern perimeter of the Site. The till was encountered at a depth of approximately 2.3 metres in the remaining boreholes. The till is identified as extending to a depth of 45.1 m

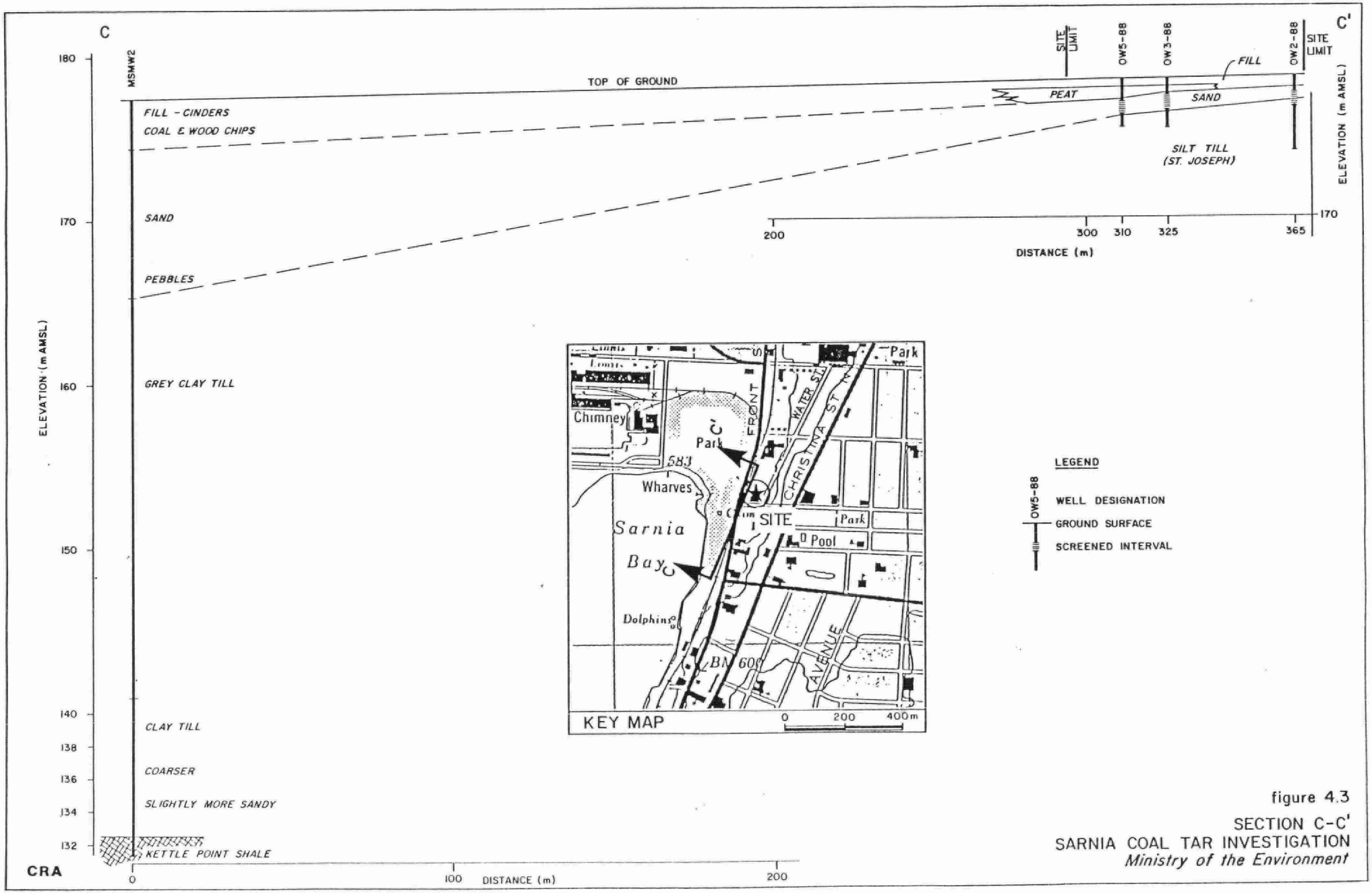

figure 4.3

SECTION C-C'

SARNIA COAL TAR INVESTIGATION

Ministry of the Environment

2299-22/09/88-3-D-1

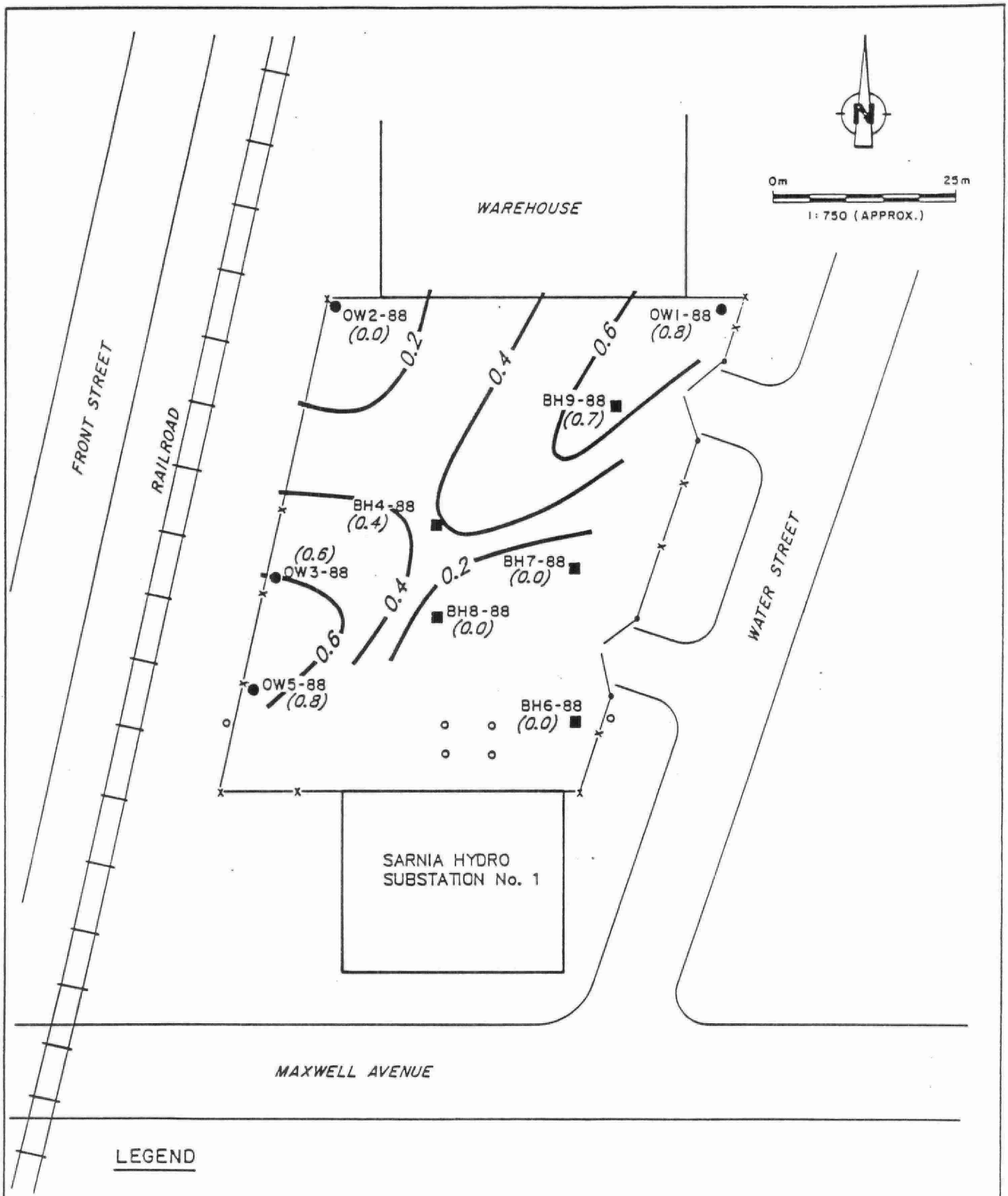

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figure 4.4

PEAT THICKNESS ISOPACH
SARNIA COAL TAR INVESTIGATION
Ministry of the Environment

2299-22/09/88-3-D-2

below ground surface at MSMW2-87 (Intera, 1987b). The till is characterized as being grey/brown and stiff, containing occasional silt partings. This till is the St. Joseph Till, referred to earlier, and acts as a regionally extensive confining unit.

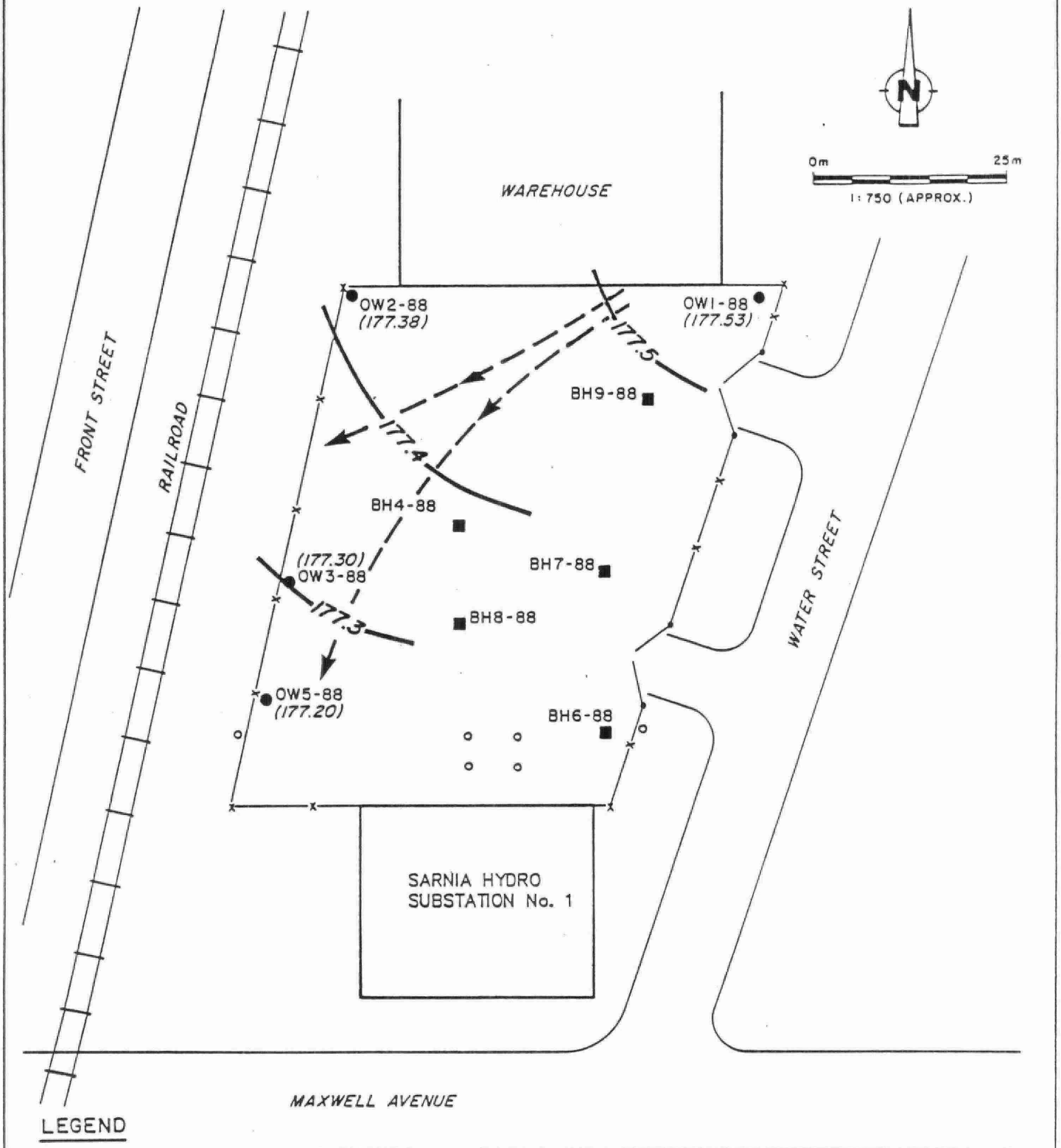
4.2.2 Site Hydrogeology

The groundwater flow system at the Site is controlled primarily by the permeable units within the glaciolacustrine deposits and the presence of the regional confining unit, the St. Joseph Till.

The hydrogeological investigation at the Site is limited to the glaciolacustrine deposits. This unit was fairly uniform across the Site, showing minor textural variation. A representative hydraulic conductivity of this unit would be in the order of 10^{-4} cm/sec.

Based on the results of the hydraulic monitoring, water table contours for May 5, 1988 have been prepared and are illustrated on Figure 4.5. Examination of this figure indicates that the horizontal flow in this unit is in a westerly direction towards Sarnia Bay. The elevation (approximately 176 m AMSL) of Sarnia Bay indicates groundwater flow in the glaciolacustrine unit discharges to the river.

Based on the water table contours presented on Figure 4.4, the horizontal gradient across the Site is approximately 0.004. Using this gradient, a representative hydraulic conductivity of 1×10^{-4} cm/sec and a



LEGEND

- HYDRO POLE
- OBSERVATION WELL LOCATION
- BOREHOLE LOCATION
- (177.20) GROUNDWATER ELEVATION (MAY 5, 1988) (m AMSL)
- —177.3— GROUNDWATER CONTOUR OVERLYING THE GLACIAL TILL
- ←— — GROUNDWATER FLOW DIRECTION

CRA

figure 4.5

GROUNDWATER CONTOURS - MAY 5, 1988
SARNIA COAL TAR INVESTIGATION
Ministry of the Environment

2299-22/09/88-3-D-2

porosity of 0.3, a horizontal groundwater velocity of 0.47 metres/year is calculated for the Site. The western boundary is approximately 125 metres (shortest distance) from Sarnia Bay (see Figure 4.3). Based on the above information, the travel time for groundwater in the glaciolacustrine deposits from the downgradient Site boundary to Sarnia Bay is in the order of 200 to 300 years.

The St. Joseph Till was not investigated during this study. However, the hydraulic conductivity for this clayey silt till is expected to approach 10^{-8} cm/sec. With this low hydraulic conductivity, the St. Joseph Till represents the base of the active groundwater flow system beneath the Site.

4.3 EXTENT OF VISUAL CONTAMINATION

A dense, non-aqueous phase liquid (NAPL) was intersected in six of the nine borings completed. Based on the waste characterization performed by Ocean Chem, the NAPL has been shown to consist predominantly of coal tar which contains PAHs (see Section 5.2). Therefore, for purposes of this report, the following definitions are used:

i) Non-Aqueous Phase Liquid (NAPL) - refers to that portion of the coal tar which is not dissolved in groundwater and can be visually identified as a separate and distinct material.

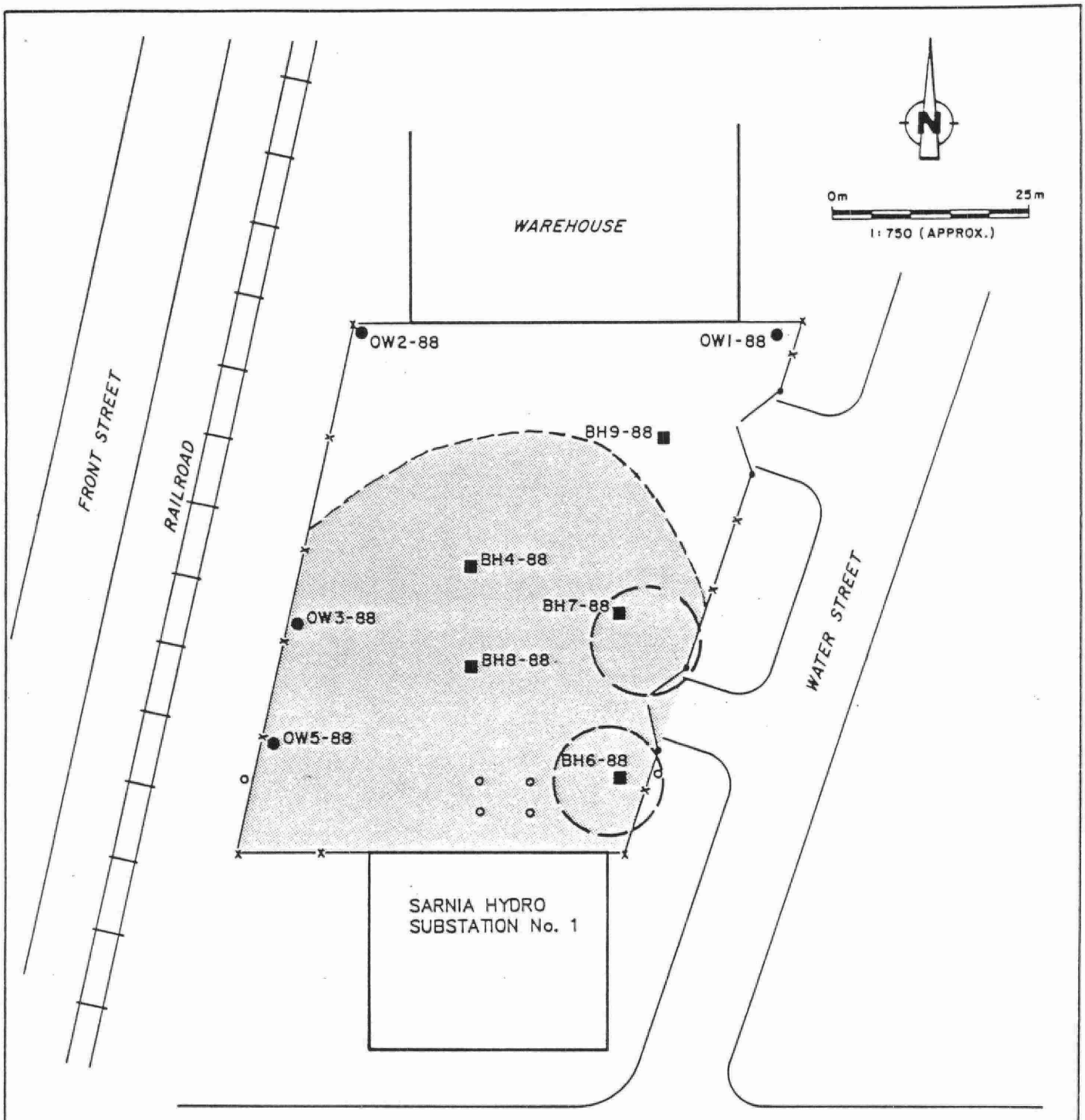
ii) Aqueous Phase Liquid (NAPL) - refers to that portion of the coal tar which is dissolved in groundwater and cannot be visually identified as a separate and distinct material.

Coal tar typically has a relative density of between 1.2 and 1.5 and a viscosity approaching 130 centipoise. Coal tar is approximately 30 percent more viscous than water. Results of the drilling program indicate that coal tar NAPL is present in the sand bed of the Glaciolacustrine deposits that overly the St. Joseph Till. The St. Joseph Till has restricted the visible downward migration of coal tar NAPL. Coal tar , more dense than groundwater will migrate under the influence of gravity following the path of least resistance.

Coal tar NAPL saturated sands cover the southern two thirds of the Site and it can be reasonably assumed, although not confirmed within the scope of this investigation, that coal tar NAPL saturated sands extend off Site in a southerly and westerly direction. Figure 4.6 illustrates the identified areal extent of coal tar NAPL saturated sands intersected in the borings. Table 4.1 summarizes the extent of coal tar NAPL observed in all boreholes completed.

4.4 REVIEW OF SERVICE PLANS

A review was conducted of all available service plans along Water Street, Maxwell Avenue and Front Street in the vicinity of the former Sarnia Coal Gasification Plant. These plans were made available to



LEGEND

- HYDRO POLE
- OBSERVATION WELL LOCATION
- BOREHOLE LOCATION
- APPROXIMATE ON-SITE AREAL EXTENT OF SATURATED COAL TAR SAND
- APPROXIMATE LOCATION OF OLD IRON GAS HOLDER

4.6

APPROXIMATE ON-SITE AREAL EXTENT OF SATURATED COAL TAR SAND
SARNIA COAL TAR INVESTIGATION
Ministry of the Environment

CRA

2299-22/09/88-3-D-3

TABLE 4.1

SUMMARY OF CONTAMINATION
OBSERVED IN BOREHOLES

Borehole Number	Ground Surface Elevation (m AMSL)	Total Depth (m BGS)	Degree of Contamination		Stratigraphic Description (1) (Depths in m BGS)	Comments (2)
OW1-88	178.53	9.10	odourless	0.0-0.5	SM-ML SAND (Fill)	Hnu (BS): < 1 ppm
			no visible	0.5-1.3	PT-PEAT	
			contamination	1.3-1.5	OL-SILT	
				1.5-4.6	CL-ML SILT (Till)	
				4.6-9.1	ML-CL SILT, CLAY	
OW2-88	178.50	4.60	odourless	0.0-0.8	SM SAND (Fill)	
			no visible	0.8-1.5	SM SAND	
			contamination	1.5-4.6	ML SILT (Till)	Hnu (BS): < 1 ppm
OW3-88	178.52	3.10	odourless sheen	0.0-0.5	SM SAND (Fill)	
			odourless	0.5-1.1	OL PEAT (Fill)	
			gross cont.	1.1-2.3	SAND	Hnu (A): 30 ppm (3)
			slight odour	2.3-3.1	ML SILT (Till)	Hnu (BS): 1 ppm
BH4-88	178.74	3.10	odourless	0.0-0.5	SM SAND (Fill)	
			odourless	0.5-0.9	OL PEAT	
			gross cont.	0.9-2.3	SM SAND	Hnu (A): 20 ppm
			slight odour	2.3-3.1	ML SILT (Till)	
OW5-88	178.60	3.10	odourless	0.0-0.5	SM SAND (Fill)	
			slight odour	0.5-1.3	PT PEAT	
			gross cont.	1.3-2.3	SM SAND	Hnu (A): 25 ppm
			slight odour	2.3-3.1	ML SILT (Till)	

continued . . .

TABLE 4.1

SUMMARY OF CONTAMINATION
OBSERVED IN BOREHOLES

Borehole Number	Ground Surface Elevation (m AMSL)	Total Depth (m BGS)	Degree of Contamination		Stratigraphic Description (1) (Depths in m BGS)	Comments (2)
BH6-88	178.62	1.80	slight odour	0.0-1.8	ML SILT (Fill)	Hnu (A): 2.5 ppm (4)
			gross cont.	at 1.8:	SM SAND	Hnu (BS): 1 ppm
						Hnu (A): 25 ppm
						Hnu (BS): 5 ppm
BH7-88	178.53	2.00	slight odour	0.0-2.0	ML SILT (Fill)	
			gross cont.	at 2.0:	SM SAND	Hnu (A): 22 ppm
						Hnu (BS): 2.5 ppm
BH8-88	178.77	2.00	slight odour	0.0-0.9	ML SILT	
			gross cont.	0.9-2.0	SM SAND	Hnu (A): 25 ppm
						Hnu (BS): 2.5 ppm
BH9-88	178.6	2.60	slight odour	0.0-0.4	SM SAND (Fill)	
			odourless	0.4-1.1	PT PEAT	
			odour	1.1-2.4	SM SAND	Hnu (A): <1 ppm
			odourless	2.4-2.6	ML SILT (Till)	

Notes: (1) Based on Unified Soil Classification System
(2) Hnu (A) - represents Hnu reading taken in the augers
Hnu (BS) - represents Hnu reading taken in the breathing space
(3) Both Hnu readings taken between depths of 1.1 - 2.3 m bgs
(4) First two Hnu readings taken between depths of 0.0 - 1.8 m bgs
Second two Hnu readings taken at depth of 1.8 m bgs

CRA by the City of Sarnia. The review was conducted to determine the physical relationship between the services and the potential migration of coal tar NAPL and/or APL off Site.

The service plans along Water Street, Maxwell Avenue and Front Street were reviewed for alignment and elevation. Those services with invert elevations less than or equal to the elevation of coal tar NAPL saturated sands and/or the static water level on Site, were considered to represent potential pathways for the migration of coal tar NAPL and/or APL. Such services were then considered and assessed for the following:

1) infiltration of coal tar NAPL and/or APL into service conduit (pipe); and

2) preferred routes of coal tar NAPL and/or APL migration along service bedding material.

Storm and sanitary sewers, in the vicinity of the Site, are gravity lines. Therefore, when installed below the static water level, the potential for groundwater infiltration into the pipes exist. Conversely, watermains are forcemains, operating under positive pressure and leakage, if any, will be in the form of exfiltration of water from the pipe. Therefore, the potential for coal tar NAPL and/or APL migration in the form of infiltration into service lines is assessed only for storm and sanitary sewers.

As discussed in Section 4.3, coal tar NAPL will migrate under the influence of gravity following the path of least resistance. The path of least resistance can be considered as the most permeable material in contact

with the NAPL. It is, therefore, necessary to compare the hydraulic conductivity of the bedding material for the services to that of the coal tar NAPL saturated sands on Site. A representative hydraulic conductivity for the sands on Site is 10^{-4} cm/sec. The hydraulic conductivity of compacted granular bedding materials is typically in the range of 10^{-3} cm/sec to 10^{-4} cm/sec. Therefore, although there is a potential for coal tar NAPL and/or APL to migrate along the service bedding material, the material is not anticipated to act as a preferred route of migration.

On June 9, 1987, water and sediment samples were collected by the MOE from four locations along the Water Street, Maxwell Avenue and Front Street storm sewers (see Figure 1, Appendix F). The Water Street storm sewer discharges to the Maxwell Avenue storm sewer on Front Street. The Front Street storm sewer drains to the south and ultimately discharges to Sarnia Bay at the foot of London Road. Samples were collected from the following locations:

Station 1: Manhole at the corner of Front Street and Maxwell Avenue- 15 -inch Ø drain

Station 2: Manhole at the corner of Front Street and Maxwell Avenue- 30-inch Ø drain.

Station 3: Manhole at the corner of Maxwell Avenue and Water Street- 24-inch Ø drain.

Station 4: Manhole along Water Street located upstream of the old manufactured gas plant site-24 inch Ø drain.

During sample collection, no apparent visual or olfactory evidence of coal tar wastes were observed. An oily type sheen, however, was observed on the surface of the water after the sediment sample was collected (i.e. disturbed). Due to this observation the water and sediment samples collected from the four stations were submitted to the MOE laboratory in Toronto for analyses.

The analytical results for the samples are presented in Appendix F. A review of the results indicates that none of the parameters detected in the storm sewer water and sediment samples were detected in the groundwater samples collected as part of this investigation (see Section 5.3).

4.4.1 Water Street

Water Street is located to the east of the Site. Coal tar NAPL was encountered in BH6-88 and BH7-88 at an elevation similar to the inverts of the existing 610 mm storm sewer situated along Water Street. The grade of this storm sewer is 0.12 percent to the south and discharges to the storm sewer on Maxwell Avenue. The storm sewer located along Water Street is situated cross-gradient to the Site. Therefore, there is no potential for APL migration from below the Site to the services on Water Street. There is a potential, however, for NAPL migration from below the Site to the storm sewer.

During a Site visit on July 13, 1988, it was noted that the City of Sarnia, Public Works Department, had excavated a portion of Water Street, directly across from the southern most gate to the Site. The excavation was approximately 2.6 metres deep and exposed 203 mm (8-inch) diameter watermain and the 610 mm (24-inch) diameter storm sewer. The bedding of the storm sewer was also exposed and no visual or olfactory evidence of coal tar NAPL was noted.

A recently constructed foundation, approximately 2.5 to 3.0 metres deep was also noted during the Site visit. The foundation was constructed on the northeast corner of Water Street and Maxwell Avenue. An inspection of the stockpiled soils adjacent to the foundation did not reveal any visual or olfactory evidence of coal tar NAPL.

Based on the site observation, the services along Water Street have not had an affect on or been affected by, the coal tar NAPL saturated sands on Site.

4.4.2 Maxwell Avenue

Maxwell Avenue is located approximately 35 metres south of and downgradient of the Site. The depth at which coat tar NAPL was encountered along the southern boundary of the Site was at similar elevations to the invert elevations of the 762 mm storm sewer and 254 mm sanitary sewer located along Maxwell Avenue. Therefore, the potential exists

for both coal tar APL and NAPL migration from below the Site to the sewers along Maxwell Avenue. However, as was discussed previously in Section 4.4, the storm sewers along Water Street, Maxwell Avenue and Front Street did not exhibit evidence of coal tar wastes.

4.4.3 Front Street

Front Street is located approximately 25 metres west of and downgradient of the Site. A railway line is located between Front Street and the Site. Coal tar NAPL was encountered in OW3-88 and OW5-88 at an elevation similar to that of the 457 mm storm sewer and above that of the 1066 mm sanitary sewer located along Front Street. Therefore, the potential exists for both coal tar APL and NAPL migration from below the Site to the sewers along Front Street. However, as was discussed previously in Section 4.4, the storm sewers along Water Street, Maxwell Avenue and Front Street did not exhibit evidence of coal tar wastes.

5.0 ANALYTICAL RESULTS

As discussed in Sections 3.2 and 3.5, soil and groundwater samples were collected for chemical analyses. The analytical results for the soil and groundwater samples are presented and assessed in the following subsections.

5.1 DATA VALIDATION

The following details an analytical data assessment and validation of the results obtained by the four analytical laboratories involved for the analytical samples collected at the Sarnia Site.

The evaluation of the analytical data was based on the information provided in the report package supplied by the contract laboratories involved, including: field duplicate data, lab blank data, field blank data, as well as recovery data from matrix and surrogate spikes. The analytical data was assessed for consistency, accuracy and precision based on the review of the recovery data as well as the comparability of the duplicate analysis.

Four laboratories were involved in the analysis of the Ingersoll samples:. Novalab Ltd., Lachine, Quebec, was responsible for the organic analyses, Beak Analytical Services, Brampton performed the metals analyses; OceanChem Group, Dartmouth, N.S. provided the organic

characterization/classification; and Conestoga-Rovers & Associates analyzed the samples for the groundwater quality indicator parameters.

Based on CRA's review of the data reported by Novalab for the organics and by Beak Analytical Services for the metals analyses, it is apparent that the data associated with the analyses of the samples are acceptable, accurate and complete with the exceptions noted in Section 5.3. Consequently, this data may be used for its original intended purpose.

5.2 WASTE CHARACTERIZATION

Two soil samples were selected and submitted to OceanChem for waste characterization. OceanChem's analytical report is presented in Appendix G.

One sample was collected from BH4-88 at a depth of approximately 1.8 meters and the second sample was collected from OW5-88 at a depth of approximately 2.1 meters. Both Samples were selected from areas of obvious coal tar saturated sands.

Both samples were characterized by capillary gas chromatography, with flame ionization detection. OceanChem reported that a high degree of overall similarity was observed in both samples. The majority of components in both samples appear to be aromatic hydrocarbons (most likely both alkylated and non-alkylated polynuclear aromatic

hydrocarbons (PAHs). Thirteen major components were observed in both samples with retention times within +/- one percent.

It can be concluded, therefore, that both samples contain a majority of PAHs and most likely originate from a common source. Since the wastes contain primarily PAHs, it is confirmed that the waste present below the Site, is coal tar.

5.3 GROUNDWATER DATA AND ASSESSMENT

A complete set of groundwater samples were collected from the observation wells and were analyzed for the parameters summarized previously on Table 3.4. One sample collected from OW3-88 was also analyzed for pesticides/PCBs.

The complete analytical reports are presented in Appendix H. The analytical data for general chemistry, trace metals and organics (volatiles and PAHs) are summarized on Tables 5.1, 5.2 and 5.3, respectively. The analytical data for the pesticides/PCBs are not summarized on a table since all parameters were below detection limits (see Appendix H).

As illustrated on Figure 4.5, presented previously, observation wells OW1-88 and OW2-88 are upgradient of the old manufactured gas plant Site. No visual or olfactory evidence of contamination was detected in either of these wells (see Table 4.1). These two

TABLE 5.1

GENERAL CHEMISTRY

Parameter	Concentration (mg/L) (1)						
	OW1-88	OW2-88	OW3-88	OW3-88 (Dup.)	OW5-88	Trip Blank	Drinking Water Guidelines
pH	6.91	6.97	6.96	6.97	6.89	7.99	6.5-8.5
Alkalinity	483	403	376	382	794	<2.0	-
Bicarb. Alk.	483	403	376	382	794	<2.0	-
Calcium	196	188	204	200	285	<1.0	-
Calcium (Beak)	174	166	200	200	200	<0.5	-
Chloride	38.0	16.0	12.0	11.0	24.0	<1.0	250*
COD	226.0	502.0	269.0	326.0	1419.0	<5.0	-
NH3-N	0.67	<0.02	0.57	1.09	1.02	0.05	-
TKN	4.86	10.47	4.43	4.74	9.16	0.28	0.15* (2)
Phenols	0.022	0.011	0.012	0.004	0.054	<0.001	0.002*
Potassium (Beak)	5.7	4.0	5.5	5.5	9.9	<0.05	-
Sodium (Beak)	38	28	12.5	12.5	26	<0.5	-
Sulfate	145.0	61.0	268.0	274.0	187.0	<1.0	500*
T O C (Beak)	12.5	2.5	18.5	19.0	27.0	<0.5	5.0*
Thiocyanate	2.60	<0.10	0.20	<0.10	1.10	<0.10	-
Sulfite	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
Hardness	572	536	616	638	904	<2.0	-

NOTES:

(1) All units in mg/L except pH and Hardness.
All analyses conducted by CRA unless otherwise noted in parameter column.
* Maximum Desirable Concentrations (Aesthetics) - Ontario Drinking Water Objectives, Revised 1983.
\- Drinking Water Guideline not available.
(2) TKN minus NH3-N

TABLE 5.2
SARNIA
TRACE METALS ANALYSIS OF GROUNDWATER

Parameter	Concentration (mg/L)						
	OW1-88	OW2-88	OW3-88	OW3-88 (Dup.)	OW5-88	TRIP BLANK	Drinking Water Guidelines
Aluminum	0.18	0.18	0.020	0.20	0.22	<0.02	-
Barium	0.07	0.05	0.04	0.04	0.09	<0.01	1.0 (1)
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Cadmium	0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.005 (1)
Chromium	0.01	0.01	0.01	0.01	0.02	<0.01	0.05 (1)
Cobalt	0.02	0.01	0.02	0.02	0.02	<0.01	-
Copper	0.020	0.060	0.015	0.015	0.005	<0.005	1.0 (2)
Iron	<0.02	<0.02	0.34	0.36	0.24	<0.02	0.3 (2)
Lead	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.05 (1)
Magnesium	30	24	31	31	67	<0.05	-
Magnesium (CRA)	20.4	16.5	26.2	30.6	46.7	<1.0	-
Manganese	0.21	0.14	0.33	0.33	0.31	<0.01	0.05(2)
Molybdenum	0.04	0.04	0.04	0.04	0.05	<0.01	-
Nickel	0.01	0.01	<0.01	0.01	<0.01	<0.01	-
Strontium	0.77	0.42	0.34	0.34	0.72	<0.01	-
Vanadium	0.015	0.015	0.010	0.010	0.015	<0.005	-
Zinc	0.11	0.39	0.10	0.11	0.06	<0.01	5.0 (2)

Notes: (1) Maximum Acceptable Concentrations (Health) - Ontario Drinking Water Objectives, Revised 1983.
(2) Maximum Desirable Concentrations (Aesthetics) - Ontario Drinking Water Objectives, Revised 1983.
All analyses conducted by Beak unless otherwise noted in parameter column.
- Drinking Water Guideline not available
All parameters for metals analysis field filtered (o.45 micron)

TABLE 5.3

SARNIA INVESTIGATION
VOLATILES AND PAH's

Parameter	Concentration (ug/l)								
	OW1-88	OW2-88	OW3-88	OW3-88 (DUP.)	Trip Blank	Lab Blank	Method Detection Limit	OW5-88	Method Detection Limit
VOLATILES:									
Benzene	-	-	2	-	-	-	2	810	10
Chlorobenzene	-	-	-	-	-	-	2	-	10
1,2-Dichlorobenzene	-	-	-	-	-	-	2	-	10
1,3-Dichlorobenzene	-	-	-	-	-	-	2	-	10
1,4-Dichlorobenzene	-	-	-	-	-	-	2	-	10
Ethylbenzene	-	-	-	-	-	-	2	310	10
A-Methylstyrene	-	-	-	-	-	-	2	-	10
Methylstyrene Isomers	-	-	-	-	-	-	2	-	10
Mesitylene	-	-	-	-	-	-	2	-	10
Toluene	-	-	3.6	4.3	3.5	-	2	47	10
M+P Xylene	-	-	-	-	-	-	2	140	10
O-Xylene	-	-	-	-	-	-	2	150	10
Other Aromatic Compounds	-	-	11	12	-	-	2	540	10
Styrene	-	-	-	-	-	-	2	TR	10
PAH's:									
Naphthalene	0.1	0.1	100	46	TR	0.05	0.05	370	5
Benzo(a)Pyrene	-	-	1.3	1.3	-	-	0.05	14	5

NOTES:

All analyses conducted by Novalab.

Other Aromatic Compounds = Total concentration of three trimethylbenzene isormers using the response factor of mesitylene.

\- Result less than method detection limit.

TR Trace compound detected.

wells, therefore, serve to monitor the background groundwater quality, relative to the Site.

Observation wells OW3-88 and OW5-88 are located along the western boundary, downgradient of the Site (see Figure 4.5). As illustrated on Figure's 4.1 and 4.2, both wells are screened within coal tar NAPL saturated sands. These two wells therefore, serve to monitor downgradient APL and NAPL concentrations, relative to the Site.

A review of the general chemistry data, summarized on Table 5.1, indicates that with the exception of alkalinity, COD, TOC and hardness in OW5-88, all parameters exhibit similar concentrations in the background and downgradient observation wells. As discussed above, observation wells OW3-88 and OW5-88 are both screened within coal tar NAPL saturated sands. Therefore, the elevated levels of the four parameters, summarized above, are not expected to be the results of coal tar contamination, but due to a localized interference in groundwater quality at OW5-88.

A review of the trace metals data, summarized on Table 5.2, indicates that with the exception of magnesium in OW5-88, all parameters exhibit similar concentrations in the background an downgradient observation wells. As discussed above, for the general chemistry parameters, the elevated level of magnesium in OW5-88 but not in OW3-88, indicates a localized interference in groundwater quality.

As summarized on Table 5.1, thiocyanate was detected in upgradient well OW1-88 at 2.6 mg/L and in well OW5-88 at 1.1 mg/L. Thiocyanates are indicators of the coal gas production process involved with sulphur removal. The concentration distribution indicates discrete areas of contamination.

A review of the data summarized on Table 5.3, indicates that no volatiles or BAP were detected in background wells OW1-88 and OW2-88. Naphthalene was detected in both of these wells, at a concentration of 0.1 ug/L, however, naphthalene was also detected in the lab blank at a concentration of 0.05 ug/L. Therefore the presence of naphthalene detected in these wells is not considered real, however, this should be confirmed through subsequent sampling.

Benzene and toluene were the volatiles detected in well OW3-88. Benzene was detected in one sample at 2 ug/L but was not detected in the duplicate sample. The method detection limit for benzene is 2 ug/L. Toluene was detected in OW3-88 at a maximum concentration of 4.3 ug/L. Toluene was also detected in the trip blank at a concentration of 3.5 ug/L. Based on the above comparisons benzene is present in OW3-88 at a concentration of approximately 2 ug/L, whereas, the toluene detected is assumed to be the results of laboratory contamination. Naphthalene was detected in OW3-88 at a maximum concentration of 100 ug/L and BAP was detected in OW3-88 at a maximum concentration of 1.3 ug/L.

Benzene, ethylbenzene, toluene and xylenes were the volatiles detected in OW5-88, at concentrations of 810 ug/L, 310 ug/L, 47 ug/L

and 290 ug/L (total xylene), respectively. Although toluene was detected in the trip blank (3.5 ug/L), the level of toluene in OW5-88 (47 ug/L), establishes the presence of toluene. Naphthalene and BAP were detected in OW5-88 at concentrations of 370 ug/L and 14 ug/L, respectively.

As discussed previously, observation wells OW3-88 and OW5-88 are screened within coal tar NAPL saturated sands. The solubility limit of BAP is 3.8 ug/L. As noted above, the concentration of BAP in OW5-88 is 14 ug/L. It can, therefore, be concluded that the sample collected from OW5-88 contained NAPL and APL coal tar and does not represent groundwater quality. Conversely, the concentration of BAP in OW3-88 is 1.3 ug/L and it can be assumed that the data reported for OW3-88 is a better representation of groundwater quality.

Under the scope of this investigation, no wells were installed off Site. However, based on the area of identified coal tar NAPL saturated sands on Site, the migration of both coal tar APL and NAPL off Site is anticipated. Due to the relatively high viscosity and low water solubility of coal tar, and the fact that a source of coal tar (i.e. gas plant) no longer exists, it is anticipated that off-Site coal tar NAPL migration is restricted to the immediate vicinity of the Site.

Groundwater contamination (APL), resulting from dissolution of coal tar components, moves with the groundwater. However, because of the limited water solubility of most coal tar components, the movement of APL contaminants may be substantially retarded in a groundwater environment, as a result of preferential partitioning of these

components onto surfaces and adsorption into organic materials. According to the "Water-Related Environmental Fate of 129 Priority Pollutants, Volume II" (Callahan, et al, 1979), prepared for the USEPA, benzene, ethylbenzene, toluene and specifically naphthalene and BAP will be adsorbed by organic material.

5.4 SUMMARY OF RESULTS

Based on information presented in the previous Sections, the following observations are made:

1) The Site is generally separated into three geologic units: fill; glaciolacustrine (interbedded peat, sand and clay) deposits; and glacial till. The fill varies in thickness from 0.4 to 2.0 metres. The total thickness of the glaciolacustrine deposits is 2.4 metres. The glacial till acts as a regionally extensive confining unit and will inhibit the vertical movement of coal tar.

2) The groundwater flow in the glaciolacustrine deposits discharges to Sarnia Bay.

3) There are no known potential drinking water users of the groundwater in the vicinity of the Site.

4) Coal tar NAPL (refers to that portion of coal tar which is not dissolved in groundwater and can be visually identified as a separate and distinct

material) saturated sands were encountered in the glaciolacustrine deposits over the southern two-thirds of the Site. The coal tar NAPL saturated sands extend down to the top of the glacial till. The distance of contamination off Site was not determined.

5) Waste characterization of the coal tar NAPL from the Site indicates that the coal tar present on Site most likely originated from a common source.

6) Based on available data, coal tar NAPL has not affected the general chemistry and trace metals parameters in the groundwater on Site. Coal tar indicator parameters (i.e. benzene, naphthalene and benzo(a)pyrene) were detected in the groundwater on Site.

7) Off-Site migration of coal tar APL (refers to that portion of coal tar which is dissolved in groundwater and cannot be visually identified as a separate and distinct material) and NAPL in the glaciolacustrine deposits are anticipated. Bedding materials of adjacent service lines do not represent a preferred route of migration.

8) Based on available data, air quality at the Site has not been affected by coal tar related parameters.

5.5 ENVIRONMENTAL SIGNIFICANCE

Based on current conditions, the coal tar NAPL on Site is covered sufficiently to prevent exposure to the waste through existing on-Site activities. Existing data also indicates that the air quality above the Site has not been affected by the presence of coal tar.

The groundwater in the glaciolacustrine deposits on Site has been impacted by coal tar APL. The groundwater in the glaciolacustrine deposits is not used as a drinking water supply and, therefore, does not represent an existing threat to human health in this respect.

The horizontal extent of the coal tar NAPL off-Site has not been determined, however, is anticipated to be restricted to the immediate vicinity of the Site. The likelihood of coal tar NAPL from the Site reaching Sarnia Bay is extremely low.

The groundwater flow in the glaciolacustrine deposits discharges to Sarnia Bay. The travel time for groundwater in the glaciolacustrine deposits from the downgradient Site boundary to Sarnia Bay was calculated to be in the order of 200 to 300 years. It can be assumed that coal tar APL migration to Sarnia Bay might occur, however, the concentrations of APL will decrease with distance from the Site. The decrease in APL concentrations would be attributable to groundwater dilution and volatilization for the volatile components (i.e. benzene and ethylbenzene) and groundwater dilution and biodegradation for the PAHs (i.e. naphthalene

and BAP). Notwithstanding the above, insufficient data is available to know how far the coal tar APL has migrated from the Site.

6.0 RECOMMENDATIONS

It is recommended that the coal tar contamination found on Site be registered on the land title. Restrictions on future land uses should include, but not be limited to, no change in land use on Site that could affect the cover over the coal tar or coal tar contaminated materials or expose the coal tar or coal tar contaminated materials to the atmosphere for a prolonged period of time. Restrictions should also include no excavation into the waste that would result in exposure unless safe excavation practices and disposal of the waste is considered.

Notwithstanding the above, the following additional work is recommended to be completed on and off the Site:

1) The completion of additional boreholes to the south and west of the Site to define the horizontal extent of coal tar NAPL saturated sands.

2) The completion of observation wells downgradient of the Site between Front Street and Sarnia Bay to determine if coal tar APL contaminants have migrated to Sarnia Bay, and if so, the effect they may have on Sarnia Bay. This work should include additional round(s) of groundwater samples from the existing observation wells and proposed observation wells.

All of Which is Respectfully Submitted,

CONESTOGA-ROVERS & ASSOCIATES

Frank A. Rovers, P. Eng.

Ed Roberts, P. Eng.

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APPENDIX A

GROUNDWATER CONDUCTIVITY AND MAGNETOMETER SURVEY RESULTS

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
10	100					3500	
20	100	58	102	80.0	6.8	5600	
30	100					5000	below hydro lines
40	100	60	50	55.0	3.6	4700	below hydro lines
50	100					4200	
60	100	30	25	27.5	-2.4	5200	
70	100					5500	
80	100	22	22	22.0	-4.4	4900	
90	100					5200	
100	100	28	28	28.0	-2.3	5400	
110	100					5300	
120	100	79	81	80.0	6.8	5600	
130	100	10	6	8.0	-13.2	5700	
140	100	40	22	31.0	-1.4	5600	
150	100					5600	
160	100	22	22	22.0	-4.4	5500	
170	100					5400	
180	100	20	20	20.0	-5.2	5400	
190	100					5000	
200	100	25	25	25.0	-3.3	5200	
210	100	49	41	45.0	1.8	4000	5 ft from fence
80	90					5200	
90	90					5400	
100	90					5400	
110	90					5700	
120	90					5900	
130	90					5900	
140	90					5900	
150	90					5800	
160	90					5700	
10	120					7000	
20	120	145	81	113.0	9.8	10400	below hydro lines
30	120					7900	below hydro lines
40	120	72	69	70.5	5.7	4500	
50	120					4500	
60	120	41	40	40.5	0.9	3600	
70	120					4500	
80	120	12	30	21.0	-4.8	4900	
90	120					6000	
100	120	40	35	37.5	0.2	5100	
110	120					5300	
120	120	20	43	31.5	-1.3	6000	
130	120	250		250.0	16.7	6000	
140	120		62	62.0	4.6	6400	
150	120	40		40.0	0.8	5600	
160	120	30	30	30.0	-1.7	5500	
170	120					5400	
180	120	22	22	22.0	-4.4	5200	
190	120					5300	

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
200	120	50	45	47.5	2.3	5000	
212	120	52	39	45.5	1.9	3800	
80	110					5100	
90	110					5700	
100	110					5900	
110	110					5800	
120	110					6200	
130	110					6100	
140	110					6800	EM31 c/phase >1000
150	110					5700	
160	110					5700	
170	110					5700	
180	110					5700	
190	110					5300	
200	110					5300	3 ft from fence
212	110					4800	
10	140	125	139	132.0	11.2	11000	below hydro lines
20	140					7700	below hydro lines
30	140					4200	
40	140	42	51	46.5	2.1	1700	
50	140					2600	
60	140	41	35	38.0	0.4	1400	
70	140					8800	
80	140	32	9	20.5	-5.0	5900	
90	140					3700	
100	140	50	50	50.0	2.7	2900	
110	140					4600	
120	140		161	161.0	12.9	5800	
130	140					5500	
140	140	79	73	76.0	6.4	5400	
150	140					5500	
160	140	30	29	29.5	-1.8	5400	
170	140					5600	
180	140	29	28	28.5	-2.1	5300	
190	140					4800	
200	140	40	40	40.0	0.8	3800	
70	130					5000	
80	130					8500	
90	130					5600	
100	130					5000	
110	130					4700	
120	130					6000	
130	130					6400	
140	130					6000	
150	130					5900	
160	130					5800	
170	130					5800	
180	130					5600	
190	130					5300	

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
200	130					4500	
10	160						
20	160	69	68	68.5	5.5	5600	beneath tree
30	160					4500	
40	160	43	41	42.0	1.2	4200	
50	160					3100	
60	160	39	41	40.0	0.8	6100	
70	160					12000	
80	160	39	51	45.0	1.8	8800	
90	160					4200	
100	160	90	95	92.5	8.1	1800	
105	160					-3000	
110	160					-3000	
115	160					1900	
120	160	52	50	51.0	2.9	3400	
130	160					4900	
140	160	12	45	28.5	-2.1	5800	
150	160					5600	
160	160	31	31	31.0	-1.4	5500	
170	160					5500	
180	160	29	29	29.0	-2.0	5500	
190	160					5500	
200	160	29	30	29.5	-1.8	4800	
212	160	55	45	50.0	2.7	3400	8 ft from building
30	150					7100	
40	150					2600	
50	150					5000	
60	150					4100	
70	150					9900	
80	150					17000	
90	150					9100	
100	150					5900	
110	150					3500	
120	150					5200	
130	150					5800	
140	150					6000	
150	150					5600	
160	150					5700	
170	150					5800	
180	150					5700	
190	150					5200	
200	150					4100	
210	150					5300	
20	180	41	29	35.0	-0.4	5300	on Water Street
30	180					1800	
40	180	41		41.0	1.0	1900	over utility ditch
50	180					-1500	offsite trenches
60	180	100	40	70.0	5.7	-1800	at fence east side
70	180					-1200	at open gate

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
80	180	80	42	61.0	4.5	-1000	
90	180					-9900	
100	180	43	41	42.0	1.2	7900	
110	180					4000	
120	180	39	39	39.0	0.6	4100	
130	180					4400	
140	180	19	30	24.5	-3.5	4800	
150	180					5500	
160	180	31	30	30.5	-1.5	5900	
170	180					5700	
180	180	28	28	28.0	-2.3	5700	
190	180					5800	
200	180	30	30	30.0	-1.7	5800	
212	180	31	37	34.0	-0.6	5700	
30	170					5700	at fence
40	170					-1100	
50	170					5400	
60	170					18500	
70	170					11500	
80	170					3800	
90	170					4500	
100	170					4100	
110	170					5200	
120	170					5400	
130	170					6000	
140	170					5700	
150	170					5800	
160	170					5800	
170	170					5700	
180	170					5700	
190	170					5400	
200	170					4900	
210	170					2500	
212	200	30	30	30.0	-1.7	5100	
200	200	31	35	33.0	-0.9	5800	
190	200					5800	
180	200	30	30	30.0	-1.7	5800	
170	200					5700	
160	200	35	32	33.5	-0.7	5600	
150	200					5300	
140	200	45	45	45.0	1.8	4600	
130	200					4100	
120	200	59	50	54.5	3.5	2300	4 ft west of fence
212	220	39	45	42.0	1.2	4000	
200	220	48	48	48.0	2.4	5900	
190	220					4200	
180	220	65	52	58.5	4.1	3700	6 ft west of fence
170	220					700	2 ft from fence
212	210	60	80	70.0	5.7	2700	NE corner of site

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
212	80	48	50	49.0	2.6	2600	
200	80	22	22	22.0	-4.4	4800	
190	80					5400	
180	80	21	21	21.0	-4.8	5800	
170	80					6000	
160	80	20	20	20.0	-5.2	5800	
150	80					5800	
140	80	30	30	30.0	-1.7	5800	
130	80					5900	
120	80	32	29	30.5	-1.5	5900	
110	80					5800	
100	80	15	25	20.0	-5.2	5600	
90	80					5600	
80	80	28	28	28.0	-2.3	5900	
70	80					5600	
60	80	27	22	24.5	-3.5	5400	
50	80					4400	
40	80	49	20	34.5	-0.5	5000	below hydro lines
30	80					5300	below hydro lines
20	80	32	100	66.0	5.2	6100	below hydro lines
10	80					4200	below hydro lines
10	60					3600	
20	60		90	90.0	7.8	5500	
30	60					4900	
40	60	32	27	29.5	-1.8	4600	below hydro lines
50	60					5200	
60	60	19	20	19.5	-5.4	5800	
70	60					5600	
80	60	21	21	21.0	-4.8	5600	
90	60					5900	
100	60	25	30	27.5	-2.4	5900	
110	60					5800	
120	60	28	29	28.5	-2.1	5900	
130	60					5800	
140	60	20	20	20.0	-5.2	6000	
150	60					5900	
160	60	20	21	20.5	-5.0	5700	
170	60					5700	
180	60	20	20	20.0	-5.2	5700	
190	60					5400	
200	60	22	22	22.0	-4.4	5000	
212	60	30	30	30.0	-1.7	3600	
180	40	30	30	30.0	-1.7	2100	2 ft east of fence
170	40					2500	3 ft east of fence
160	40	30	30	30.0	-1.7	3600	
150	40					4600	
140	40	20	20	20.0	-5.2	4700	
130	40					5200	
120	40	21	19	20.0	-5.2	6000	

APPENDIX A

Ground Conductivity and Magnetometer Survey Results
Sarnia Coal Tar

North	East	Parallel	Perp.	Average	Decibel	Mag	Comments
110	40					5300	
100	40	29	29	29.0	-2.0	5500	
90	40					5500	
80	40	22	19	20.5	-5.0	5400	
70	40					6800	
60	40	22	12	17.0	-6.6	5700	
50	40					5700	
40	40	35	35	35.0	-0.4	5500	below hydro lines
30	40					5300	
20	40	29	30	29.5	-1.8	5000	
10	40					4300	
10	20					4900	
20	20	30	20	25.0	-3.3	5000	
30	20					5600	below hydro lines
40	20	31	27	29.0	-2.0	6300	
50	20					4600	
60	20	27	27	27.0	-2.6	3900	5 ft east of fence
70	20					2400	at fence
10	10	32	15	23.5	-3.8	3700	

BACKGROUND READINGS - taken 10 ft outside of west fence.

	32	32.0	-1.1
	32	36	34.0	-0.6
	33	36	34.5	-0.5
	27	33	30.0	-1.7
	41	38	39.5	0.7
	35	34	34.5	-0.5
	30	31	30.5	-1.5
	29	29	29.0	-2.0
	30	31	30.5	-1.5
	32	33	32.5	-1.0
	34	32	33.0	-0.9
	33	33	33.0	-0.9
	34	32	33.0	-0.9
	36	34	35.0	-0.4
	36	36	36.0	-0.1
	39	37	38.0	0.4
	35	42	38.5	0.5
	52	48	50.0	2.7
	46	42	44.0	1.6
	44	37	40.5	0.9
	54	30	42.0	1.2
	52		52.0	3.1

NOTES: - North, East are grid coordinates
- Parallel, Perp are EM31 readings obtained with the instrumen
parallel or perpendicular (Perp) to the line of traverse
- Average is of parallel and perpendicular EM31 readings
- Decibel: normalized EM31 readings
- Mag are Gradiometric Magnetometer readings

APPENDIX B

STRATIGRAPHIC AND INSTRUMENTATION LOGS

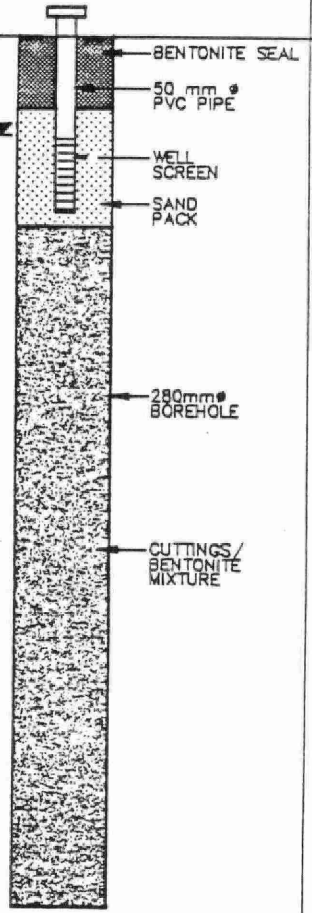
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: SARNIA COAL TAR
PROJECT NO.: 2299
CLIENT: MOE
LOCATION: REFER TO PLAN

HOLE DESIGNATION: OW1-88
DATE COMPLETED: 11/03/88
DRILLING METHOD: 168mm ID HSA
CRA SUPERVISOR: S.C./K.M.V.

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL
	REFERENCE ELEVATION	179.238
	GROUND ELEVATION	178.53
1.0	SM-ML SAND (FILL): some silt, foundry sand, medium grained, poorly graded, compact, grey, moist, No Frost.	177.99
	PT PEAT: amorphous, slightly fibrous in a woody matrix, semi consolidated	177.51
2.0	OL SILT: little sand, trace clay, soft, layered, low plastic, grey, very moist, inclusions of shells, rootlets.	177.25 / 177.01
3.0	CL-ML SILT (TILL): some clay, trace sand, trace to little gravel, stiff, low plastic, grey-brown, moist, inclusions of shale	
4.0	-becomes very stiff, brown, higher percentage of fine gravel	
5.0	ML - SILT (TILL): some clay, trace sand, stiff, low plastic, grey/brown, moist to very moist	173.96
6.0		
7.0		
8.0		
9.0	END OF HOLE @ 9.14m BGS	169.39
10.0		
11.0		
12.0		
13.0		

MONITOR INSTALLATION



SCREEN DETAILS:
Screened Interval:
176.70 to 177.46m AMSL
Length - 0.76m
Diameter - 50mm
Slot # 10
Material - PVC

SAMPLE NUMBER	STATE	'N' VALUE
1CS		
2CS		
3CS		
4CS		
5CS		
6CS		

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

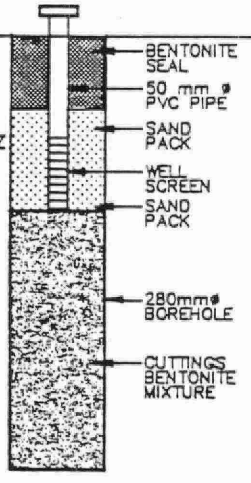
GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (5/05/88)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: SARNIA COAL TAR
PROJECT NO.: 2299
CLIENT: MOE
LOCATION: REFER TO PLAN

HOLE DESIGNATION: OW2–88
DATE COMPLETED: 11/03/88
DRILLING METHOD: 168mm ID HSA
CRA SUPERVISOR: S.C./K.M.V.

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	REFERENCE ELEVATION GROUND ELEVATION	*179.527* *178.50*				
1.0	SM SAND (FILL): some silt, trace gravel, brown, moist, Foundry sand	*177.76*				
	SM – SAND: some gravel, well graded, brown, wet	*177.36* ▽ *177.00*				
2.0	ML SILT (TILL): some clay, little sand, trace fine gravel, stiff, low plastic, occasional thin silt partings, becomes less sandy with depth, grey/brown becoming brown at 2.7m					
3.0						
4.0						
5.0	END OF HOLE @ 4.57m BGS	*173.95*				
	NOTES: 1. water entering hole from aprox. 1.22–1.52 m bgs					
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						
13.0						



SCREEN DETAILS:
Screened Interval:
176.67 to 177.43m AMSL
Length – 0.76m
Diameter – 50mm
Slot # 10
Material – PVC

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (5/05/88)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: SARNIA COAL TAR
PROJECT NO.: 2299
CLIENT: MOE
LOCATION: REFER TO PLAN

HOLE DESIGNATION: OW3-88
DATE COMPLETED: 14/03/88
DRILLING METHOD: 168mm ID HSA
CRA SUPERVISOR: S. CROSSMAN

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	REFERENCE ELEVATION GROUND ELEVATION	179.436 178.52				
1.0	SM SAND (FILL)– Foundry sand: some silt, oily sheen on sample.	178.19	BENTONITE SEAL 280mm ø BOREHOLE 50 mm ø PVC PIPE SAND PACK WELL SCREEN	1CS		
	OL PEAT (FILL): some sand, amorphous, fibrous, compact, water bearing at 1.2m, wet, bricks, steel, wood, inclusions, sandseams at 1.2m.	177.58 177.30				
2.0	SM – SAND: some silt, COAL TAR SATURATED, compact, medium grained, poorly graded, black, strong PAH odour, wet					
	ML SILT (TILL): some clay, little sand, stiff, low plastic, brown, moist, visibly free of contamination, slight PAH odour	176.36		2CS		
3.0	END OF HOLE @ 3.05m BGS	175.60				
4.0	NOTES: 1. augers cleaned with water & methanol before moving to new location.		SCREEN DETAILS: Screened Interval: 175.47 to 177.00m AMSL Length – 0.9m Diameter – 50mm Slot # 10 Material – PVC			
5.0						
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						
13.0						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (5/05/88)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: SARNIA COAL TAR
HOLE DESIGNATION: OW5-88

PROJECT NO.: 2299
DATE COMPLETED: 14/03/88

CLIENT: MOE
DRILLING METHOD: 168mm ID HSA

LOCATION: REFER TO PLAN
CRA SUPERVISOR: S.C./K.M.V.

DEPTH m BG	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION m AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	REFERENCE ELEVATION GROUND ELEVATION	178.213 178.60				
1.0	Foundry sand (FILL): some silt, compact	178.13	BENTONITE SEAL 280mm ø BOREHOLE 50 mm ø PVC PIPE SAND PACK WELL SCREEN	1CS		
	PT PEAT: amorphous, slightly fibrous, semi-consolidated, very moist, black, slight PAH odour	177.31 ▼				
2.0	SM SAND: some silt, compact, medium grained, poorly graded, black, COAL TAR SATURATED, wet, free product in form of globs	177.24 ▽		2CS		
3.0	ML SILT: some clay, trace sand, trace fine gravel, stiff, low plastic, brown, moist, visibly free of contamination, slight PAH odour	176.27				
	END OF HOLE @ 3.05m BGS	175.54				
4.0			SCREEN DETAILS: Screened Interval: 176.40 to 177.23m AMSL Length - 0.9m Diameter - 50mm Slot # 10 Material - PVC			
5.0						
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						
13.0						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (5/05/88)

APPENDIX C

MANIFEST

Ministry of the Environment / Ministère de l'Environnement

Ontario

MANIFEST / MANIFESTE

"Regulation 309, R.R.O. 1980, Form 1." "Règlement 309, R.R.O. de 1980, formule 1."

CONFORMS TO TRANSPORTATION OF DANGEROUS GOODS REGULATIONS UNDER TDG ACT, CHAPTER 36, S.C. 1980

CONFORME AU REGLEMENT SUR LE TRANSPORT DES MARCHANDISES DANGEREUSES S'APPLIQUANT DE LA LOI SUR LE TDG, CHAPITRE 36, S.C. 1980

P 93469-5

(Instructions on Reverse) / (Instructions au verso)

A Generator (Consignor) / Producteur (Expéditeur)

Generator Registration No. (Provincial No.) / (Nº provincial): ONO 199878

Company Name / Nom de la compagnie: Ontario Ministry of the Environment

Head Office Address / Adresse du siège social: 40 St. Clair Ave W 5th Flr.

City / Ville: Toronto

Prov: Ont

Postal Code / Code postal: M4V 1P5

Shipping Site Address / Adresse du lieu d'expédition: Boundary Maxwell St., Water St., and Front St.

City / Ville: Sarnia

Prov: Ont

Postal Code / Code postal:

Intended Receiver (Consignee) / Réceptionnaire (Destinataire) prévu: Tricil Ltd.

Receiver No. / Nº du réceptionnaire (Provincial No.) / (Nº provincial): A1013180

Receiving Site Address / Adresse du lieu de réception: RR #1

City / Ville: Corunna

Prov: Ont

Postal Code / Code postal: NON 1G0

B Carrier / Transporteur

Certificate of Approval No. (Provincial No.) / (Nº provincial): A-1858

Company Name / Nom de la compagnie: TRICIL

Address / Adresse: RR#1

City / Ville: Corunna

Prov: Ont

Postal Code / Code postal:

Registration / Enregistrement	License Plate No. / Nº de plaque d'immatriculation	Prov. / Prov.
Vehicle / Véhicule	-PC51-5161-	ONT
Trailer # 1 / 1re remorque	-9721-B5H1-	ONT
Trailer # 2 / 2e remorque		

Point of entry / Point d'entrée: NA

Point of exit / Point de sortie: NA

Carrier Certification: I declare that the information contained in Section B is correct and complete
Déclaration du transporteur: J'atteste que les renseignements inscrits à la partie B sont exacts et complets

Name of Driver (print) / Nom du conducteur (lettres moulées): MARK A LABRASCEUR

Tel No (Area Code) / Nº de tel (ind. rég.):

Signature: Mark A Labrasceur

Day / Jour: 13 Mon / Mois: 07 Yr / An: 88

C Receiver (Consignee) / Réceptionnaire (Destinataire)

Receiver No. (Provincial No.) / (Nº provincial):

Company Name / Nom de la compagnie:

Address / Adresse:

City / Ville:

Prov.:

Postal Code / Code postal:

Receiving Site Address / Adresse du lieu de réception:

City / Ville:

Prov.:

Postal Code / Code postal:

Date Received / Date de réception — Day / Jour, Mon. / Mois, Yr. / An:

Time / Heure: ☐ A.M. ☐ P.M.

Circulation No (Quebec only) / Nº de circulation (réservé au Québec):

Other Manifest Number(s) / Autre(s) numéro(s) de manifeste(s):

Physical State (Solid, Liquid, Gas) / État physique (Solide, liquide, gaz)	Shipping Name of Waste / Appellation réglementaire des déchets transportés	Waste Identification No. / Nº d'identification des déchets — Provincial	Waste Identification No. — TDGA LTMD	Quantity Shipped / Quantité expédiée	Units L / kg Unités	Classification	Packing Group / Groupe d'emballage	Concentration	Packaging Contenants — No / Nbre de contenants	Packaging Contenants — Codes	Quantity Received / Quantité reçue	Units L / kg Unités	Identify Any Shipment Discrepancy/Problems. Attach addendum if necessary. / Indiquer toute différence relative à l'expédition. Annexer une feuille au besoin	Handling Code / Code de manutention	Decontamination Packaging Contenants Yes / Oui	Decontamination Packaging Contenants No / Non	Decontamination Vehicle Yes / Oui	Decontamination Vehicle No / Non
S	Waste cont. w/coal tar	212217	N/A	APROX 112715	KG	N/A	N/A	—	7	01								

Special Handling Emergency Instructions / Instructions spéciales de manutention ou en cas d'urgence: Attached / Annexées ☐ Below / Ci-dessous ☐

If handling code "other" specify / Si le code de manutention est "autre", préciser:

If waste to be transferred specify intended company name / Si les déchets doivent être transférés, préciser le nom du destinataire:

Receiver No. / (Provincial No.) / Nº du réceptionnaire (Nº provincial):

Address / Adresse:

City / Ville:

Prov:

Date Shipped / Date d'expédition — Day / Jour, Mon / Mois, Yr / An: 13 07 88

Time / Heure: 1151 ☒ AM ☐ PM

Scheduled Arrival Date / Date d'arrivée prévue — Day / Jour, Mon / Mois, Yr / An: 13 07 88

Generator (Consignor) Certification: I declare that the information contained in Section A is correct and complete.
Déclaration du producteur (expéditeur): J'atteste que les renseignements inscrits à la partie A sont exacts et complets.

Name of Authorized Person (print) / Nom de la personne autorisée (lettres moulées): E. L. Ricks

Signature: E. L. Ricks

Tel No (Area Code) / Nº de tel (ind. rég.):

Receiver (Consignee) Certification: I declare that the information contained in Section C is correct and complete.
Déclaration du réceptionnaire (destinataire): J'atteste que les renseignements inscrits à la partie C sont exacts et complets.

Name of Authorized Person (print) / Nom de la personne autorisée (lettres moulées):

Signature:

Tel No (Area Code) / Nº de tel (ind. rég.):

APPENDIX D

ALLOWABLE SANITARY SEWER DISCHARGE RATE

ATTACHMENT 1

ALLOWABLE SANITARY SEWER DISCHARGE RATE

In order to satisfy MOE guidelines, the following equation calculates the allowable discharge rate of collected waters to the sanitary sewer:

$$Q_{DS} = (C_{EFF})(Q_{WWTP})/(S_{BAP})(1 - E_{WWTP})$$

where:

Q_{DS} = Allowable discharge rate of waters to sanitary sewer (litre/min.)

C_{EFF} = Maximum allowable incremental increase in WWTP effluent discharge (ug/L)

Q_{WWTP} = Average WWTP operating flow rate (litre/min.)

S_{BAP} = Solubility limit of BAP (ug/L)

E_{WWTP} = Assumed WWTP removal rate for BAP

For the Sarnia site:

C_{EFF} = 0.01 ug/L (based on MOE guideline)

Q_{WWTP} = 11,000,000 gpd = 34,757 litre/min (based on information from City of Sarnia)

S_{BAP} = 3.8 ug/L

E_{WWTP} = 0.7 (based on MOE guideline)

Therefore:

Q_{DS} = (0.01)(34,757)/(3.8)(1 - 0.7) = 305 litre/min.

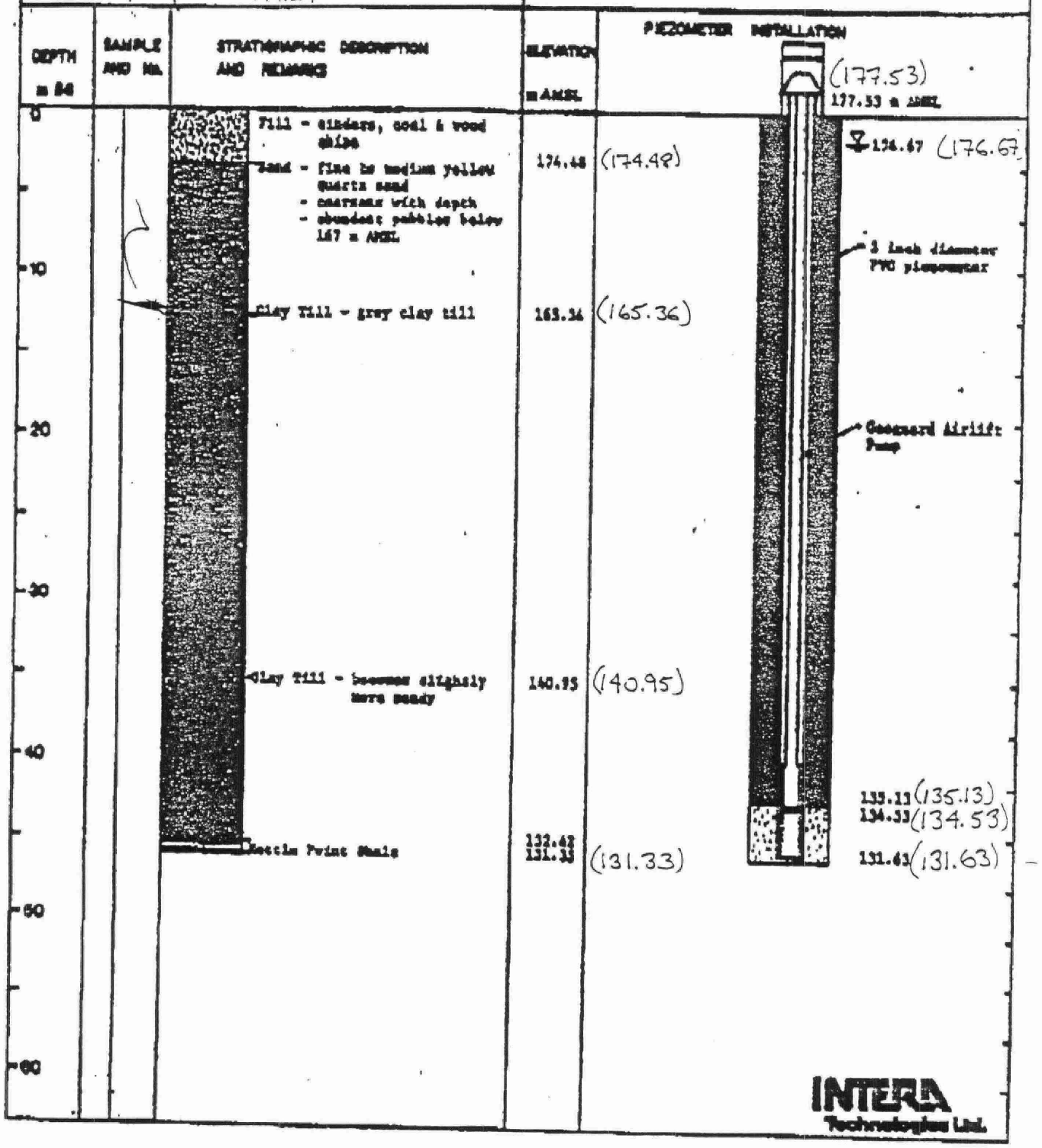
Based on the above, the discharge of collected waters to the sanitary sewers at a rate of 305 litres/min. would satisfy the MOE guidelines.

APPENDIX E

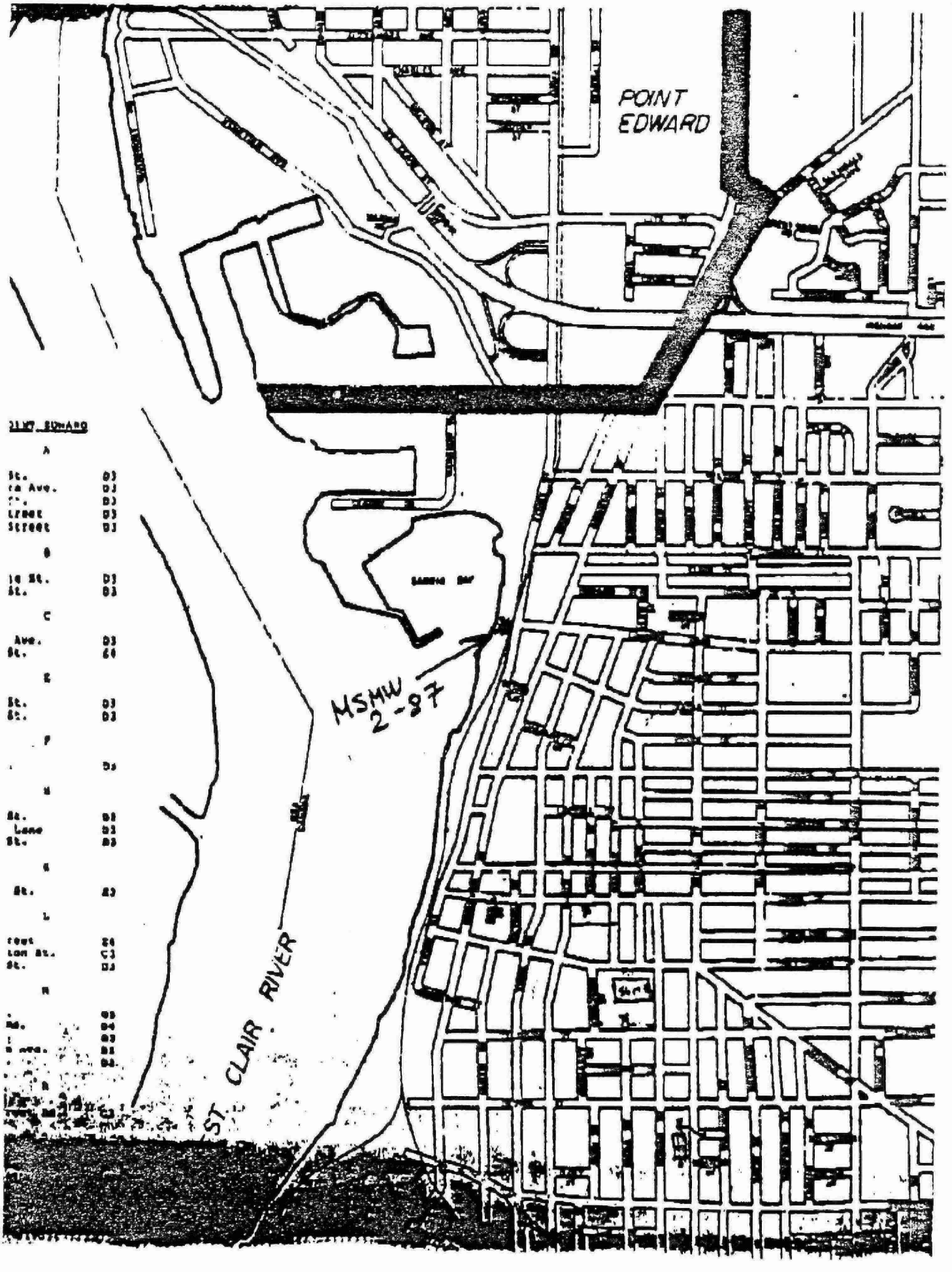
MSMW2 WELL LOG

STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME AND No.: Barrie, 567-038	BOREHOLE No.: MSW-1-87
CLIENT: Ontario Ministry of the Environment	DATE COMPLETED: August 7, 1987
LOCATION: Barrie (Centennial Park)	DRILLING METHOD: Mud Rotary, 5 1/4 inch bit
REFERENCE ELEVATION: 179.24 m AMSL (177.24)	DRILL SUPERVISOR: J. Karila, D. Belanger



INTERA Technologies Ltd.


POINT EDWARD
MSMW 2-87
ST CLAIR RIVER

APPENDIX F

MOE STORM SEWER

SAMPLE RESULTS

MEMORANDUM July 14, 1987

TO: D. Veal
Chief
Surface Water Assessment Unit

FROM: B. Hawkins
Biological Technician

RE: Sarnia - Old Gas Works Site

A one day field investigation was conducted in the vicinity of the old Sarnia Gas Works facility on June 9, 1987. The purpose of the investigation was to determine if any coal gas wastes were migrating off site and if so to define the surface water quality impact.

The site is located on Maxwell Street, bounded by Water and Front Streets (Figure 1). The property is now occupied by Sarnia Hydro who operate a hydro-electric substation. The actual former gas plant site is fenced and access is controlled by a locked gate. The site is located approximately 125 m east of the St. Clair River.

Drainage on site consists of a number of storm drains. The Water Street storm drain discharges to the Maxwell Street drain which discharges to the Front Street drain which ultimately discharges to the St. Clair River at the foot of London Road.

Water and sediment samples were collected from the drainage network at the following sites:

Station 1: Manhole at the corner of Front and Maxwell Streets - 15 inch drain.

Station 2: Manhole at the corner of Front and Maxwell Streets - 30 inch drain.

Station 3: Manhole at the corner of Maxwell and Water Streets - 24 inch drain.

Station 4: Manhole on Water Street above the old Gas Works Site - 24 inch drain.

No apparent visual or olfactory signs of coal tar wastes were observed at any of the above sites. There was however, an oily type sheen present on the surface of the water after the sediment was disturbed. Based on this observation, the samples were submitted to our Toronto lab (LIS - SW12859) for analyses.

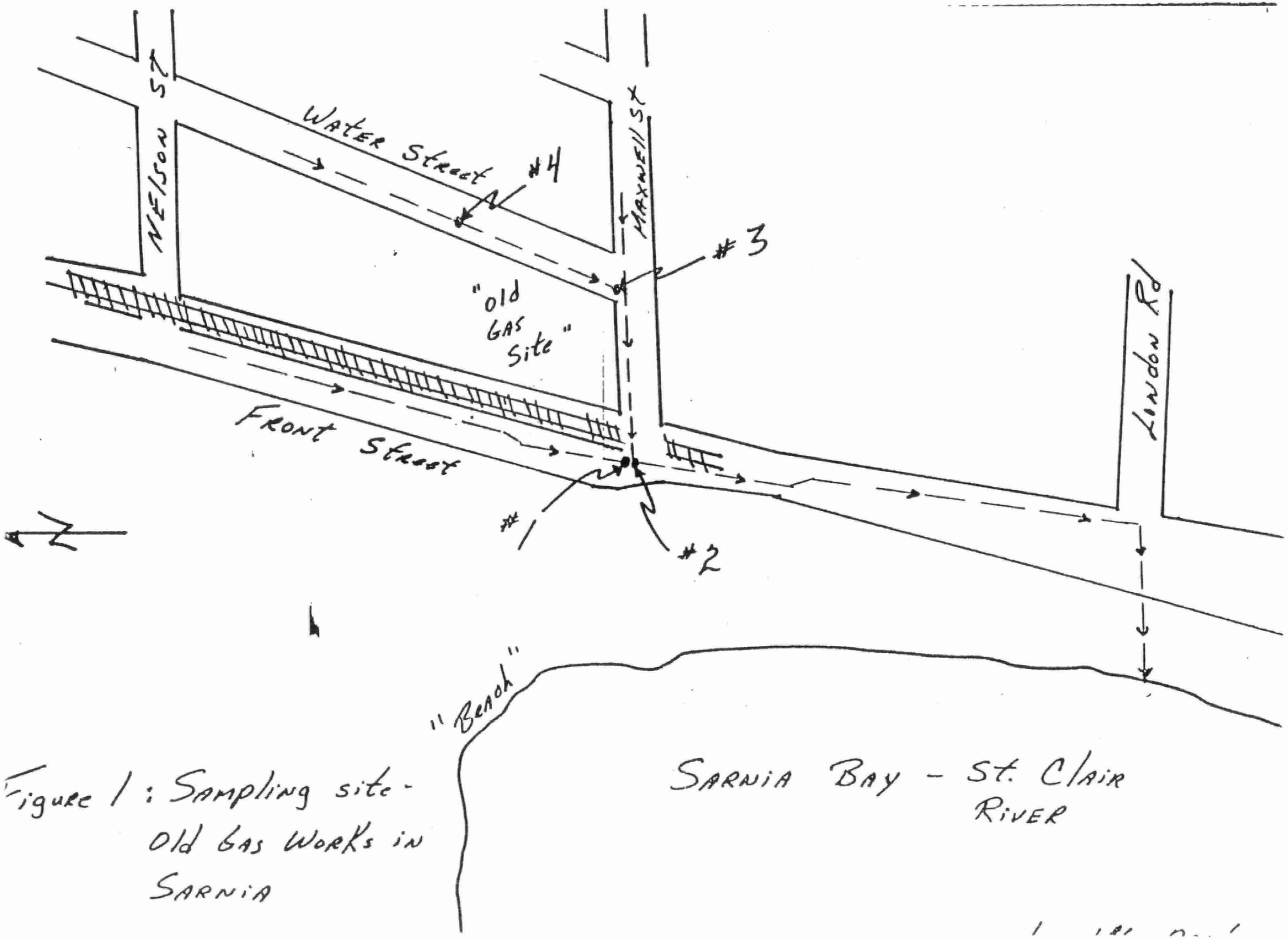


Figure 1: Sampling site - Old Gas Works in Sarnia

On July 6, 1987 the writer received verbal results as to the presence or absence of coal tar wastes. Those preliminary results did not indicate the presence of coal tar wastes. A more comprehensive set of results is expected shortly.

B. Hawkins

BH:jeb
sw/071401

cc S. Thornley
C. Ramchandani

Municipality/Project: S A R N I A G A S W O R K S Submission: S W 1 2 8 5 9

Sampling Date(s): J U N 0 9, 1 9 8 7

Program..... 010030810 SURFACE WATER STUDY WRB-RUNOFF
Agency..... 0101010401 SURFACE WATER UNIT

Sampled by: HAWKINS, BURCE. Date Submitted: 10/06/87, Date Received: 12/06/87

..... Mail this copy to ..... Hawkins, B
TECHNICAL SUPPORT
985 ADELAIDE ST. S.
LONDON ONT
N6E 1V3

Final reports to Hawkins, B TECHNICAL SUPPORT Telephone: 519-661-2200

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
1	CODE NOT GIVEN	SARNIA 15" DRAIN FROM FRONT STREET	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0259			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
2	CODE NOT GIVEN	30" DRAIN ON MAXELL ST MANHOLE COMBINED	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0260			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
3	CODE NOT GIVEN	24" ON WATER STREET	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0261			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
4	CODE NOT GIVEN	24" ON WATER ST UPSTREAM OF SITE	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0262			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
5	CODE NOT GIVEN	SARNIA 15" DRAIN FROM FRONT STREET	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0263			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
6	CODE NOT GIVEN	30" DRAIN ON MAXELL ST MANHOLE COMBINED	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0264			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
7	CODE NOT GIVEN	24" ON WATER STREET	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0265			

TESTS REQUESTED: +IDGW

Field Sample	Sampling Location	Sampling Location Description	Sampling Date	Time	Zone
8	CODE NOT GIVEN	24" ON WATER ST UPSTREAM OF SITE	09/06/87		5

Sample Description	Lab Sample#	Remarks	Lab Sample#	Remarks
NOT GIVEN	SP24-0266			

TESTS REQUESTED: +IDGW

Sample Class: SP Results

SPECTROSCOPY PEST Inquiries at: JOE OSBORNE
Telephone: 416-235-5759

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Sampling Time	Zone
1	CODE NOT GIVEN	SARNIA 15" DRAIN FROM FRONT STREET NOT GIVEN	SP24-0259		09/06/87		5
2	CODE NOT GIVEN	30" DRAIN ON MAXELL ST MANHOLE COMBINED NOT GIVEN	SP24-0260		09/06/87		5
3	CODE NOT GIVEN	24" ON WATER STREET NOT GIVEN	SP24-0261		09/06/87		5
4	CODE NOT GIVEN	24" ON WATER ST UPSTREAM OF SITE NOT GIVEN	SP24-0262		09/06/87		5
5	CODE NOT GIVEN	SARNIA 15" DRAIN FROM FRONT STREET NOT GIVEN	SP24-0263		09/06/87		5
6	CODE NOT GIVEN	30" DRAIN ON MAXELL ST MANHOLE COMBINED NOT GIVEN	SP24-0264		09/06/87		5

Field Sample Number...	1	2	3	4	5	6
Test Description Code, Units of Measure Method	SP24-0259	SP24-0260	SP24-0261	SP24-0262	SP24-0263	SP24-0264
ID-G. WYHOVSZKY OTC	!RP	!RP	!RP	!RP	!RP	!RP
IDGW ,No Units available						

Sample Class: SP Results

SPECTROSCOPY PEST Inquiries at: JOE OSBORNE
Telephone: 416-235-5759

Field Sample	Sampling Location	Sampling Location Description / Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
7	CODE NOT GIVEN	24" ON WATER STREET NOT GIVEN	SP24-0265		09/06/87		5
8	CODE NOT GIVEN	24" ON WATER ST UPSTREAM OF SITE NOT GIVEN	SP24-0266		09/06/87		5

Test Description Code, Units of Measure / Method	Field Sample Number... 7	8
	SP24-0265	SP24-0266
ID-G. WYHOVSZKY OTC IDGW ,No Units available	IRP	IRP

Sample Class: SP Textual Information

SPECTROSCOPY PEST Inquiries at: JOE OSBORNE
Telephone: 416-235-5759

SUBMISSION: SW12859
AUTHORED BY: MIRA PETRANOVIC
SCIENTIST - TRACE ORGANICS SECTION

SP24-0259 WAS FOUND TO CONTAIN POLYSTYRENE/ACRYLATE.
SP24-0260 AND -0261 DID NOT CONTAIN ANY MAJOR ORGANICS.
SP24-0262 AND -0263 WERE FOUND TO CONTAIN ACRYLICS.
SP24-0264 AND -0265 WERE FOUND TO CONTAIN A MIXTURE OF
SILICONE GREASE AND RESIN (NATURALLY OCCURING MATERIAL DERIVED
FROM TREES IE: PINE TAR)

SP24-0259 TO -0266 WERE FOUND TO BE FREE OF COAL TAR.
SP24-0266 WAS FOUND TO CONTAIN A MEDIUM OIL ALKYD.

REMARK CODE EXPLANATIONS

RMK	DESCRIPTION
!RP	SEE ATTACHED REPORT (NO NUMERIC RESULT) PESTIC.

*** END OF REPORT ***

APPENDIX G

WASTE CHARACTERIZATION REPORT

OceanChem group

Consultants in Chemistry to the Environmental and Earth Sciences

SUITE 32
1000 WINDMILL ROAD
DARTMOUTH, NOVA SCOTIA
B3B 1L7
TELEPHONE (902) 463-0114
FAX (902) 466-5743

2846
April 29, 1988

Mr. Wayne J. Smith, C.E.T.,
Conestoga-Rovers & Associates Limited,
651 Colby Drive,
Waterloo, Ontario.
N2V 1C2

RE: CHARACTERIZATION OF SARNIA/INGERSOL SAMPLES, REF.# 2299

Dear Mr. Smith;

We have completed the characterization of the following samples received from you;

OceanChem Sample Number	Sample Description
1770	Sarnia Coal Tar, 03-14-88, BH 4, (6 ft.) Pesticide, (coal Tar)
1771	Sarnia Coal Tar, 03-14-88, OW5-88, (7 ft.) Pesticide, (coal tar)
1772	BH 5-88, Ingersol
1773	Ingersol Coal Tar, 03-29-88, BH12-88, (11 ft.)
1774	Ingersol BH3-88, CS#5, (25 ft.)

All samples were characterized by capillary gas chromatography, with flame ionization detection.

Sample #s 1770, 1771, (Sarnia)

A high degree of overall similarity was observed in both samples. The majority of components in both samples appear to be aromatic hydrocarbons (most likely both alkylated and non-alkylated polynuclear aromatic hydrocarbons, (PAH). With reference to a detailed pattern comparison, 13 major components were observed in both samples with retention times within +/- 1%. There is therefore a high degree of likelihood that the hydrocarbon fraction of the samples originated from a common source.

Sample #s 1772, 1773, 1774, (Ingersol)

In general, a high degree of chromatographic pattern similarity was observed in all three samples. Similar to the above Sarnia samples, #s 1770, and 1771, the capillary gas chromatographic data of the Ingersol samples is consistent with the presence of both alkylated and non-alkylated polynuclear aromatic hydrocarbons (PAH). A high degree of similarity was observed in all three samples, however sample # 1774 (BH-3), contained several early eluting compounds, not observed in sample #s 1772 (BH-5), and 1773 (BH-12). Although the identity of these compounds has not been established by confirmatory techniques such as capillary gas chromatography/mass spectroscopy, (GC/MS), the identity of these additional early eluting compounds appears to be consistent with the presence of polynuclear aromatic hydrocarbons, (PAH).

In conclusion, both sets of samples appear to contain a majority of PAH, and within each set, (geographic location), most likely originate from a common source.

If you have any questions, or require any additional information, please do not hesitate to contact me.

Yours truly,
OCEANCHEM GROUP

G.R.Sirota
Senior Project Manager

GRS.lb

cc. Ms.Chris Galinski
Mr.Paul Plotz

APPENDIX H

ANALYTICAL REPORTS

2299

NOVALAB LTÉE LTD

9420 CÔTE DE LIESSE, LACHINE, QUÉ. H8T 1A1

TÉL.: (514) 636-6218, 631-1838
TELEX: 05-822787 • (LYNJON)
FAX: (514) 631-9814

TO: Conestoga-Rovers & Associates Ltd
86 Rankin Street
Waterloo, Ontario
N2V 1C2

Attention: Mr. W. Smith

DATE: April 20, 1988

CLIENT ORDER #: 2299

REPORT #: NL-3513

RE: Analysis of Water Samples for MAH, Naphthalene, and Benzo(a)Pyrene - Project 2299

Sir,

Twelve (12) water samples, received March 25, 1988, were analysed for monocyclic aromatic hydrocarbons by purge and trap gc/ms (EPA method 624), and for indicator polycyclic aromatic hydrocarbons (naphthalene and benzo(a)pyrene) by gc/ms equipped with a mass selective in the single ion monitoring mode (EPA method 625). Due to a computer problem in which the data for the first analysis was lost, samples "Ingersoll #2" to "Ingersoll #6" had to be analysed a second time for MAH. The results presented here are from that second analysis. Duplicates for "Ingersoll #1" and the trip blank were also analysed. These duplicates showed a slight increase in toluene which may be due to contamination incurred after the initial sampling.

Chromatograms will be kept on file.

Sincerely,

NOVALAB LIMITED

B.E. Crowley, B.Sc.

Approved by J.D. Fenwick, Ph.D., P.Chem.

BEC/hl
encl.

CONCENTRATION OF MONOCYCLIC AROMATIC HYDROCARBONS IN WATER

ug/L

COMPOUND	OW5 Sarnia #40	MDL	OW2 Sarnia #10	OW1 Sarnia #20	OW3 Sarnia #30	OW3 DUP Sarnia #50	OW3 Ingers. #1	OW4 Ingers. #2	OW2A Ingers. #3	OW1 Ingers. #4	MDL
BENZENE	810	10	-	-	2	-	-	27	2.3	TR	
CHLOROBENZENE	-	10	-	-	-	-	-	-	-	-	
1,2-DICHLOROBENZENE	-	10	-	-	-	-	-	-	-	-	
1,3-DICHLOROBENZENE	-	10	-	-	-	-	-	-	-	-	
1,4-DICHLOROBENZENE	-	10	-	-	-	-	-	-	-	-	
ETHYLBENZENE	310	10	-	-	-	-	-	7.7	-	-	
A-METHYLSTYRENE	-	10	-	-		-	-	-	-	-	
METHYLSTYRENE ISOMERS	-	10	-	-	-	-	2.4	2.7	-	-	
MESITYLENE	-	10	-	-	-	-	-	-	-	-	
TOLUENE	47	10	-	-	3.6	4.3	-	8.5	6.3	TR	
M+P-XYLENE	140	10	-	-	-	-	-	5.8	-	-	
O-XYLENE	150	10	-	-	-	-	-	18	-	-	
OTHER AROMATIC COMPOUNDS	540	10	-	-	11	12	6.8	49	-	-	
STYRENE	TR	10	-	-	-	-	-	-	-	-	

CONCENTRATION OF MONOCYCLIC AROMATIC HYDROCARBONS IN WATER

ug/L

COMPOUND	Boiler Ingers. #5	Trip Blank	Lab Blank	OW3 DUP Ingers. #6	OW3 DUP (duplicates) Ingers. #1	Trip Blank	MDL
BENZENE	TR	-	-	TR	TR	TR	2
CHLOROBENZENE	-	-	-	-	-	-	2
1,2-DICHLOROBENZENE	-	-	-	-	-	-	2
1,3-DICHLOROBENZENE	-	-	-	-	-	-	2
1,4-DICHLOROBENZENE	-	-	-	-	-	-	2
ETHYLBENZENE	-	-	-	-	-	-	2
A-METHYLSTYRENE	-	-	-	2	2	-	2
METHYLSTYRENE ISOMERS	-	-	-	-	-	-	2
MESITYLENE	-	-	-	-	-	-	2
TOLUENE	3.8	3.5	-	4.4	5	11	2
M+P-XYLENE	-	-	-	-	-	-	2
O-XYLENE	-	-	-	-	-	-	2
OTHER AROMATIC COMPOUNDS	-	-	-	6.9	7.2	-	2
STYRENE	-	-	-	-	-	-	2

MDL = METHOD DETECTION LIMITS

OTHER AROMATIC COMPOUNDS = Total concentration of trimethylbenzenes using the response factor of mesitylene.

CONCENTRATION OF NAPHTHALENE AND BENZO(A)PYRENE IN WATER SAMPLES
ug/L

	SAMPLE	Naphthalene	Benzo(a) Pyrene	Surrogate Standard Recovery (%) d8-Naphthalene	d12-Perylene
	Trip Blank	TR	-	70.4	60.3
OW2	Sarnia #1	0.1	-	68.6	51.5
OW1	Sarnia #2	0.1	-	71.3	55.3
OW3	Sarnia #3	100	1.3	64.8	42.6
OW3 DUP	Sarnia #5	46	1.3	92.6	57.5
OW3	Ingersoll #1	50	-	77.5	88.3
OW4	Ingersoll #2	* 112	-		63.6
OW2A	Ingersoll #3	* 2	-		52.3
OW1	Ingersoll #4	0.05	-	76.1	56.6
Bailer	Ingersoll #5	0.1	-	63	72.3
OW3 DUP	Ingersoll #6	37	-	60	62.2
	Lab Blank	0.05	-	64.1	69.6
	Detection Limits	0.05	0.05		
OW5	Sarnia #4	370	14	84.5	36.4
	Detection Limits	5	5		

* = Due to low d8-naphthalene extraction recovery, these values are calculated from the purgeables analysis data.

2299

NOVALAB LTÉE LTD

9420 CÔTE DE LIESSE, LACHINE, QUÉ. H8T 1A1

TEL.: (514) 636-6218, 631-1838
TELEX: 05-822787 • (LYNJON)
FAX: (514) 631-9814

TO: Conestoga-Rovers & Associates Ltd.
86 Rankin Street
Waterloo, Ontario
N2V 1C2

Attention: Mr. W. Smith

DATE: May 24, 1988

CLIENT ORDER #: 2299

REPORT #: NL-3613

RE: Analysis of Water for Pesticides - Project 2299

Sir,

One (1) water sample, received April 28, 1988, was analysed for PCB and organochlorinated pesticides by gas chromatography with electron capture detection. Results and detection limits are shown in the attached Tables.

Chromatograms will be kept on file.

Sincerely,

NOVALAB LIMITED

B.E. Crowley, B.Sc.

Approved by J.D. Fenwick, Ph.D., P.Chem.

John D. Fenwick
74-024
Québec

BEC/hl
encl.

Table I - Concentration of Organochlorinated Pesticides in Water (µg/L)

Compound	043 #3 OBS. Well Sarnia	MDL
HCB	ND	0.005
Heptachlor	ND	0.005
Aldrin	ND	0.005
p.p'-DDE	ND	0.005
Mirex	ND	0.05
α-BHC	ND	0.005
β-BHC	ND	0.005
Lindane	ND	0.005
δ-BHC	ND	0.005
Heptachlor Epoxide	ND	0.005
Cis-Chlordane	ND	0.005
trans-Chlordane	ND	0.005
o,p'-DDD	ND	0.005
o,p'-DDT	ND	0.005
p,p'-DDD	ND	0.005
p,p'-DDT	ND	0.005
Methoxychlor	ND	0.05
α-Endosulfan	ND	0.005
Dieldrin	ND	0.005
Endrin	ND	0.05
β-Endolsufan	ND	0.005
Endrin Aldehyde	ND	0.05
Endosulfan Sulfate	ND	0.05
Toxaphene	ND	0.5

Table II - Concentration of PCB in Water (µg/L)

Compound	#3 OBS. Well Sarnia	MDL
Aroclor 1242	ND	0.05
Aroclor 1248	ND	0.05
Aroclor 1254	ND	0.02
Aroclor 1260	ND	0.02

beak analytical services
A division of Beak Consultants Limited

14 Abacus Road
Brampton, Ontario
Canada L6T 5B7

Tel: (416) 458-4044
Fax: (416) 458-7303

report of analysis

Rec'd CRA

To: Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario
N2V 1C2

Project No.: 95[illegible]
Date Received: 88.03.25
Date Analyzed: 88.04.15
No. of Samples: 12 (4128)
Sample Type: Groundwater
Reference: #2299
Sarnia/Ingersoll

Attention: Ms. Debra Hayes

BAS REF #		Ing. ow3 T9665	Ing. ow4 T9666	Ing. ow2A T9667	Ing. ow1 T9668	Ing. Bailer T9669
SAMPLE DESCRIPTION		#1	#2	#3	#4	#5
PARAMETER	UNIT					
TOC	mg/L	1.5/1.5	3.5	1.5	1.5	3.0
DCP Scan:	mg/L					
Zinc		0.11	0.03/0.04	0.04	0.08	<0.01
Cadmium		0.0001	<0.0001	<0.0001	<0.0001	<0.0001/<0.0001
Manganese		0.59	0.62/0.63	1.68	0.57	<0.01
Cobalt		0.02	0.01/0.01	0.02	0.02	<0.01
Copper		0.020	0.030/0.030	0.065	0.055	<0.005
Iron		0.02	<0.02/<0.02	<0.02	<0.02	<0.02
Lead		<0.001	<0.001	<0.001	<0.001	0.008/0.009
Chromium		0.01	<0.01/<0.01	0.01	0.01	<0.01
Nickel		0.02	<0.01/<0.01	0.01	0.01	<0.01
Beryllium		<0.01	<0.01	<0.01	<0.01	<0.01/<0.01
Molybdenum		0.08	0.03	0.09	0.07	<0.01/<0.01
Calcium		180	109	167	182	0.20/0.20
Vanadium		0.015	0.005	0.015	0.015	<0.005/<0.005
Aluminum		0.20	0.14	0.18	0.20	<0.02/<0.02
Magnesium		38	18.2	37	34	<0.05/<0.05
Barium		0.17	0.05	0.23	0.20	<0.01/<0.01
Potassium		17.1	9.0	15.8	19.4	<0.05/<0.05
Strontium		2.9	0.60	4.4	2.1	<0.01/<0.01
Sodium		100	15.5	240	86	<0.5/<0.5

Approved

beak analytical services
A division of Beak Consultants Limited

14 Abacus Road
Brampton, Ontario
Canada L6T 5B7

Tel: (416) 458-4044
Fax: (416) 458-7303

report of analysis

To: Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario
N2V 1C2

Attention: Ms. Debra Hayes

Project No.: 9599 Page 2
Date Received: 88.03.25
Date Analyzed: 88.04.15
No. of Samples: 12 (4128)
Sample Type: Groundwater
Reference: #2299
Sarnia/Ingersoll

		Ing. OW3(Dup)	Sarn. OW2	Sarn. OW1	Sarn. OW3	Sarn. OW5
BAS REF #		T9670	T9671	T9672	T9673	T9674
SAMPLE DESCRIPTION		#6	#10	#20	#30	#40
PARAMETER	UNIT					
TOC	mg/L	1.5	2.5	12.5/12.5	18.5	27
DCP Scan:	mg/L					
Zinc		0.10/0.10	0.39	0.11	0.10	0.06/0.05
Cadmium		0.0002	0.0001	0.0001	<0.0001	<0.0001
Manganese		0.60/0.60	0.14	0.21	0.33	0.31/0.31
Cobalt		0.02/0.02	0.01	0.02	0.02	0.02/0.02
Copper		0.020/0.020	0.060	0.020	0.015	0.005/0.005
Iron		0.02/0.02	<0.02	<0.02	0.34	0.24/0.24
Lead		<0.001	0.001	<0.001	<0.001	<0.001
Chromium		0.02/0.01	0.01	0.01	0.01	0.02/0.01
Nickel		0.02/0.02	0.01	0.01	<0.01	<0.01/<0.01
Beryllium		<0.01	<0.01	<0.01	<0.01	<0.01/<0.01
Molybdenum		0.07	0.04	0.04	0.04	0.05/0.06
Calcium		187	166	174	200	200/230
Vanadium		0.015	0.015	0.015	0.010	0.015/0.015
Aluminum		0.20	0.18	0.18	0.020	0.22/0.22
Magnesium		39	24	30	31	67/67
Barium		0.17	0.05	0.07	0.04	0.09/0.10
Potassium		17.6	4.0	5.7	5.5	9.9/10.0
Strontium		2.9	0.42	0.77	0.34	0.72/0.71
Sodium		102	28	38	12.5	26/26

Approved

beak analytical services
A division of Beak Consultants Limited

14 Abacus Road
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Canada L6T 5B7

Tel: (416) 458-4044
Fax: (416) 458-7300

report of analysis

To: Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario
N2V 1C2

Attention: Ms. Debra Hayes

Project No.: 9599 Page 3
Date Received: 88.03.25
Date Analyzed: 88.04.15
No. of Samples: 12 (4128)
Sample Type: Groundwater
Reference: #2299
Sarnia/Ingersoll

BAS REF #		Sarn ow3(Dup) T9675	Ing. & Sarnia T9676
SAMPLE DESCRIPTION		#50	TRIP BLANK
PARAMETER	UNIT		
TOC	mg/L	19.0	<0.5
DCP Scan:	mg/L		
Zinc		0.11	<0.01
Cadmium		0.0001	<0.0001
Manganese		0.33	<0.01
Cobalt		0.02	<0.01
Copper		0.015	<0.005
Iron		0.36	<0.02
Lead		0.001	0.001
Chromium		0.01	<0.01
Nickel		0.01	<0.01
Beryllium		<0.01	<0.01
Molybdenum		0.04	<0.01
Calcium		200	<0.05
Vanadium		0.010	<0.005
Aluminum		0.20	<0.02
Magnesium		31	<0.05
Barium		0.04	<0.01
Potassium		5.5	<0.05
Strontium		0.34	<0.01
Sodium		12.5	<0.5

NOTE: Unless otherwise instructed samples will be retained for three weeks following completion of analysis.

Approved

beak analytical services

A division of Beak Consultants Limited

14 Abacus Road
Brampton, Ontario
Canada L6T 5B7

Tel: (416) 458-4044
Fax: (416) 458-7300

report of analysis

To: Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario
N2V 1C2

Attention: Ms. Debra Hayes

Project No.: 9599 Page 4
Date Received: 88.03.25
Date Analyzed: 88.04.15
No. of Samples: 12 (4128)
Sample Type: Groundwater
Reference: #2299
Sarnia/Ingersoll

PARAMETER	UNITS	REFERENCE MATERIAL DESCRIPTION	TRUE VALUE	ANALYSED VALUE	DATE ANALYSED
TOC	mg/L	WP1284#3	6.1	6.8	88.04.18
	mg/L	WP1284#4	91.1	94.4	88.04.18
Zinc	mg/L	WP386	0.100	0.105	88.04.06
Cadmium	mg/L	WS378#3	0.0020	0.0020/0.0019	88.04.14
Manganese	mg/L	WS378#3	0.100	0.097	88.04.14
Cobalt	mg/L	WS378#3	0.100	0.096	88.04.14
Copper	mg/L	WS378#3	0.100	0.100	88.04.14
Iron	mg/L	WS378#3	0.100	0.101	88.04.14
Lead	mg/L	WS378#3	0.017	0.017	88.04.14
Chromium	mg/L	WS378#3	0.100	0.094	88.04.14
Nickel	mg/L	WS378#3	0.100	0.094	88.04.14
Beryllium	mg/L	WP386	0.100	0.097	88.04.07
Molybdenm	mg/L	WP686	5.0	4.93/4.99	88.04.07
Calcium	mg/L	WP686	5.0	4.88/4.98	88.04.07
Vanadium	mg/L	WP386	0.250	0.244	88.04.07
Aluminum	mg/L	ICAP-7	0.97	1.06	88.04.07
	mg/L	WP386	0.500	0.532	88.04.07
Magnesium	mg/L	WP686	0.5	0.50/0.50	88.04.07
Barium	mg/L	ICAP-7	0.97	0.99	88.04.07
	mg/L	WP386	5.0	4.98/4.94	88.04.07
Potassium	mg/L	ICAP-7	10.0	10.9	88.04.07
Sodium	mg/L	ICAP-7	0.86	1.0	88.04.07
	mg/L	WP686	1.0	1.2	88.04.07

Approved